DOCUMENTS

OF THE

ASSEMBLY

OF THE

STATE OF NEW YORK

ONE HUNDRED AND FORTIETH SESSION

1917

VOL. VI.—NO. 11—PART 5

ALBANY
J. B. LYON COMPANY, PRINTERS
1917

State of New York—Department of Agriculture.

THIRTY-FIFTH ANNUAL REPORT

OF THE

New York Agricultural Experiment Station.

(GENEVA, ONTARIO COUNTY)

FOR THE YEAR 1916.

With Reports of Director and Other Officers.

TRANSMITTED TO THE LEGISLATURE JANUARY 15, 1917

ALBANY
J. B. LYON COMPANY, PRINTERS
1917

STATE OF NEW YORK.

No. 11.

IN ASSEMBLY

JANUARY 15, 1917.

THIRTY-FIFTH ANNUAL REPORT

OF THE

BOARD OF CONTROL OF THE NEW YORK AGRICULTURAL EXPERIMENT STATION.

STATE OF NEW YORK:

DEPARTMENT OF AGRICULTURE,

ALBANY, *January* 15, 1917.

To the Legislature of the State of New York:

As Commissioner of Agriculture, and as President of the Board of Control, I have the honor to submit herewith the Thirty-fifth Annual Report of the Director of the New York Agricultural Experiment Station, at Geneva, N. Y., in pursuance of the provisions of the Agricultural Law.

I am, respectfully yours,

CHARLES S. WILSON,

Commissioner.

BOARD OF CONTROL.

OFFICERS OF THE BOARD.

STATION STAFF.

Address all correspondence, not to individual members of the staff, but to the New York Agricultural Experiment Station, Geneva, N. Y.

The Bulletins published by the Station will be sent free to any farmer applying for them.

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[1] Appointed November 8, 1915; resigned June 30, 1916.
[2] Appointed July 1, 1916.
[3] Absent on leave from September 30, 1915, to September 1, 1916.
[4] Appointed October 1, 1915; resigned August 31, 1916.
[5] Appointed July 1, 1916.
[6] Connected with Grape Culture Investigations.
[7] Absent on leave from June 1, 1915, to September 15, 1916.
[8] Appointed June 15, 1915; resigned September 15, 1916.
[9] Resigned October 1, 1916.
[10] Appointed July 1, 1916.
[11] Appointed February 15, 1916.

TABLE OF CONTENTS.

Treasurer's Report 1
Director's report 7
Report of the Department of Bacteriology:
Counting bacteria by means of the microscope 37
Are spore-forming bacteria of any significance in soil under normal conditions? 66
A possible function of Actinomycetes in soil 73
The number of colonies allowable on satisfactory agar plates 82
A comparison between agar and gelatin as media for the plate method of counting bacteria 91
Report of the Department of Botany:
Observations on some degenerate strains of potatoes 97
Tree crickets as carriers of *Leptosphaeria coniothyriam* (Fckl.) Sacc. and other fungi 136
Cork, drouth spot and related diseases of the apple 156
Lime-sulphur vs. bordeaux mixture as a spray for potatoes, IV 206
Report of the Department of Chemistry:
Measurements of soil fertility 215
Plant food for crops in 1916 239
Chemical changes in the souring of milk 247
Concerning the utilization of inosite in the animal organism 257
I. Concerning the effect of inosite upon the respiratory exchange in the dog 258
II. The effect of inosite upon the metabolism of man 264
Concerning certain aromatic constituents of urine 271
Report of the Department of Entomology:
Plant lice injurious to apple orchards 297
The cabbage maggot: Its biology and control 340
The leaf-weevil 402
Miscellaneous notes on injurious insects 424
Some insects attacking the pear, and their control 453
The cherry leaf-beetle 471
Periodical cicada in 1916 474
Report of the Department of Horticulture:
Some notes on the breeding of raspberries 481
New or noteworthy fruits, IV 495
New or noteworthy fruits, V 503
Culture and forcing of Witloof chicory 510
Culture of cabbage 520
Inspection Work:
Seed tests during 1915 527
Analyses of samples of commercial fertilizers 547
Inspection of feeding stuffs 607
Appendix:
Reprints of " Popular Editions " of bulletins:
Apple aphides and their control 759
Breeding raspberries 766
Witloof chicory 769
The cabbage maggot and its work 772
Some disappointing seed potatoes 778
Some new or rare fruit pests 782
Periodicals received by the Station 787
Meteorological records for 1916 795
Index 807

THIRTY-FIFTH ANNUAL REPORT

OF THE

Board of Control of the New York Agricultural Experiment Station.

TREASURER'S REPORT.

GENEVA, N. Y., *July* 1, 1916.

To the Board of Control of the New York Agricultural Experiment Station:

As Treasurer of the Board of Control, I respectfully submit the following report for the fiscal year[1] ending June 30, 1916:

INVESTIGATIONS.

APPROPRIATIONS 1915–1916.

1915	*Receipts.*	*Dr.*
Oct. 1.	To balance on hand	$1,744 19
	To amount received from Comptroller	17,823 46
		$19,567 65

[1] From October 1, 1915 only, owing to change in fiscal year by Legislature.

Expenditures.	*Cr.*
By real estate	$612 00
By real estate maintenance	192 55
By office maintenance	1,566 29
By laboratory equipment	1,956 38
By laboratory maintenance	402 20
By farm equipment	847 31
By farm maintenance	4,062 16
By heat, light and water	242 86
By office equipment	331 40
By publications	369 96
By miscellaneous	2,668 71
By remitted to State Treasurer	443 91
By traveling expenses	2,036 26
By balance	3,835 66
	$19,567 65

GENERAL EXPENSE — HEAT, LIGHT, WATER, APPARATUS, REPAIRS, ETC.

1915.	*Receipts.*	*Dr.*
Oct. 1.	To balance on hand	$5 07
	To amount received from Comptroller	4,437 25
		$4,442 32

Expenditures.	*Cr.*
By real estate maintenance	$1,829 02
By furniture and fixtures	1,691 57
By remitted to State Treasurer	2 00
By balance	919 73
	$4,442 32

SALARIES.

1915.		*Receipts.*	*Dr.*
Oct.	1.	To balance on hand	$4,753 93
		To amount received from Comptroller	39,571 81
			$44,325 74

	Expenditures.	*Cr.*
	By salaries	$39,228 40
	By balance	5,097 34
		$44,325 74

LABOR.

1915.		*Receipts.*	*Dr.*
Oct.	1.	To balance on hand	$771 75
		To amount received from Comptroller	14,637 77
			$15,409 52

	Expenditures.	*Cr.*
	By labor	$13,189 58
	By balance	2,219 94
		$15,409 52

GRAPE INVESTIGATION FUND.

1915.		*Receipts.*	*Dr.*
Oct.	1.	To balance on hand	$241 60
		To amount received from Comptroller	6,713 88
			$6,955 48

Expenditures.	*Cr.*
By real estate maintenance	$9 52
By office maintenance	19 88
By laboratory equipment	209 65
By laboratory maintenance	48 87
By farm equipment	79 00
By farm maintenance	956 53
By heat, light and water	38 06
By labor	999 20
By miscellaneous	592 72
By office equipment	3 85
By salaries	2,916 69
By remitted to State Treasurer	87 25
By traveling expenses	280 24
By balance	714 02
	$6,955 48

FERTILIZERS, FEEDING STUFFS, ETC.

1915.	*Receipts.*	*Dr.*
Oct. 1.	To balance	$469 66
	To amount received from Comptroller	12,232 28
		$12,701 94

Expenditures.	*Cr.*
By laboratory equipment	$205 76
By laboratory maintenance	545 42
By office equipment	19 00
By heat, light and water	281 60
By labor	1,046 77
By miscellaneous	132 99
By salaries	9,485 50
By remitted to State Treasurer	178 13
By traveling expenses	198 52
By balance	608 25
	$12,701 94

FIELD, ORCHARD AND MILK INVESTIGATIONS.

1915.		*Receipts.*	*Dr.*
Oct.	1.	To balance	$34 54
		To amount received from Comptroller	10,265 25
			$10,299 79

	Expenditures.	*Cr.*
	By labor	$2,121 77
	By farm maintenance	23 00
	By salaries	7,612 29
	By remitted to State Treasurer	11 54
	By balance	531 19
		$10,299 79

HATCH FUND.

1915.		*Receipts.*	*Dr.*
Oct.	1.	To receipts from the Treasurer of the United States as per appropriation for fiscal year ended June 30, 1916, as per act of Congress approved March 2, 1887	$1,500 00

	Expenditures.	*Cr.*
	By building and repairs	$9 30
	By contingent expenses	7 20
	By freight and express	16 21
	By heat, light and water	25 14
	By labor	134 13
	By postage and stationery	17 76
	By salaries	1,174 86
	By seeds, plants and sundry supplies	85 28
	By traveling expenses	17 09
	By balance	13 03
		$1,500 00

ADAMS FUND.

1915.	Receipts.	Dr.
Oct. 1.	To receipts from the Treasurer of the United States as per appropriation for fiscal year ended June 30, 1916, as per act of Congress approved March 2, 1887	$1,500 00
	Expenditures.	*Cr.*
	By salaries	$1,275 04
	By scientific apparatus	90 00
	By balance	134 96
		$1,500 00

RING MEMORIAL FUND.

Balance on hand October 1, 1916	$1,000 00
I have received and remitted to the State Treasurer for the fiscal year ending July 1, 1916, for produce sold	$2,687 29

All expenditures are supported by vouchers approved by the Auditing Committee of the Board of Control and have been forwarded to the Comptroller of the State of New York.

(Signed) W. O'HANLON,
Treasurer.

DIRECTOR'S REPORT FOR 1916.*

To the Honorable Board of Control of the New York Agricultural Experiment Station:

Gentlemen.— It again becomes my duty to present to you a report of another year's operations of this institution, which I shall accompany by a discussion of certain conditions affecting the institution and of our continued needs.

The work of the Station during 1916 has continued along much the same lines as during previous years. As now organized, the institution occupies a broad field of inquiry and the problems considered touch almost every phase of agricultural practice. It has become a question, in view of the increased cost of maintaining such an institution and of failure to secure additional funds commensurate with the increased expense and demands for assistance, whether the scope of our activities is not too broad. We may seriously ask whether a fuller concentration upon fewer problems would not be more beneficial to the agriculture of the State. There are still pressing needs of the institution which have not been met, and to which I shall take the liberty of calling your attention.

ADMINISTRATION.

STATION STAFF.

Changes in the Station Staff have been less than in some former years. Charles B. Tubergen, B.S., who was connected with the horticultural department of the institution for a period of over five years, resigned on October first to enter upon commercial work. During these years of service, Mr. Tubergen established very pleasant relations with his associates, and he carries with him the hearty wishes of his friends for success in his new field of effort.

Edward J. Lewis, B.S., Assistant Chemist in the agronomy department, resigned after a somewhat brief stay at the institution in order to further prosecute his studies in chemistry.

John C. Baker, Ph.D., was appointed on July first to fill the vacancy caused by the resignation of Alfred W. Bosworth late in 1915. Mr. Baker pursued special studies at Columbia University in biological chemistry, and received from that institution the degree

* This is a reprint of Bulletin No. 428, December, 1916.

of Doctor of Philosophy. For the present, he will be engaged in the chemical department in the study of problems relating to milk and milk products.

William W. Baer, B.S., has been appointed to the position of Assistant Chemist in the department of agronomy to fill the vacancy caused by the resignation of Edward J. Lewis. Mr. Baer is a graduate of the Pennsylvania State College.

William C. Stone, M.S., a graduate of the University of Vermont and for several years an assistant in the Experiment Station at that institution, having given attention during that time to special problems in plant breeding, has been selected to fill the vacancy caused by the resignation of Charles B. Tubergen. Mr. Stone enters upon his duties on the first of January, 1917.

The institution is fortunate in retaining the continued services of the heads of the various divisions of the scientific staff. This is not because attractive opportunities have not come to them through offers from other institutions, but because of a devotion to their work and a loyalty to the institution which leads them to remain in the service of the people of this State.

Under the new fiscal policy of the State, it will without any question be increasingly difficult to secure long-continued service on the part of members of the staff, especially when financial interests are seriously involved. The fundamental law establishing the institution states that the Board of Control "may employ competent and suitable chemists and other experts and persons necessary for carrying on the work of the Station and shall fix the compensation of all persons connected with the work of said Station." The autonomy of the Board of Control is now seriously limited in this direction inasmuch as the salaries of the members of this staff are now fixed by the budget committees, subject of course to legislative enactment. Any policy which involves promotion, and no scientific institution can be managed successfully without a policy of promotion for meritorious service, can now hardly be sustained, as the legislative mind is more sensitive towards increases of salaries in our educational institutions than towards almost any other line of expenditure. In several ways the policy and management of the Station by its Board of Control have been seriously disturbed through various fiscal and other regulations. It cannot be too strongly urged by those whom the Station is expected to serve that

the policy of the State should be to appropriate what money it thinks it can afford for the support of the institution and leave its policy and management to those more intimately acquainted with its conditions and needs.

MAINTENANCE FUNDS.

The fiscal law of the State of New York was amended by the Legislature of 1916 by changing the fiscal year so that it begins on July 1 instead of October 1. This brings the actual expenditure of the funds provided nearer to the time when the various departments and institutions of the State must make recommendations for their budget, but even under the new arrangement the items for the budget are requested not less than nine months before the beginning of the fiscal year to which the budget is to be applied.

The following were the appropriations made available for the fiscal year beginning July 1, 1916:

GENERAL FUND.

Salaries	
Administration	$13,200.00
Research	56,000.00
Labor	
Classified	6,760.00
Regular and temporary	14,797.88
Special service	174.80
	$90,872.68
Maintenance and operation	29,700.00
Total	$120,572.68

INSPECTION FUND.

Salaries	$13,070.00
Labor	
Regular and temporary	1,482.42
	$14,552.42
Maintenance and operation	2,400.00
Total for inspection	$16,952.42
Total appropriation 1916–17	$137,525.10

Salaries for all divisions	$82,270.00
Labor (Classified)	6,700.00
Labor (Regular and temporary)	16,280.30
Special service	174.80
Maintenance and operation	32,100.00
Total	$137,525.10

This is $6,215.00 less than was deemed necessary by the Board of Control for the maintenance of the institution.

The appropriations requested for the fiscal year beginning July 1, 1917, are as follows:

GENERAL FUND

Salaries		
Administration	$13,420.00	
Research	57,300.00	
		$70,720.00
Labor		
Classified		6,820.00
Regular and temporary		16,000.00
Special services		1,674.80
		$95,214.80
Maintenance and operation		32,075.00
		$127,289.80

INSPECTION FUND

Salaries	$13,670.00
Labor, regular and temporary	1,515.00
	$15,185.00
Maintenance and operation	2,400.00
Total for inspection	$17,585.00
Total appropriation requested	$144,874.80

Salaries for all divisions	$84,390.00
Labor (Classified)	6,820.00
Labor (Regular and temporary)	17,515.00
Special service	1,674.80
Maintenance and operation	34,475.00
Total	$144,874.80

I trust it will be possible for your Board to urge upon the Legislature with the utmost emphasis the need of returning to the former budget system under which appropriations were made to this institution. As it is now, your Director is asked to recommend specific sums along specific lines, such as fuel, light, power and water, printing, equipment, supplies, hired horses and vehicles, traveling expenses, communication (which includes freight, express, telegraph and telephone bills), general plant service (which means horseshoeing, laundry work and the employment of outside men for general repairs), and rent. The expenditures of an Experiment Station, if it is doing the work it ought to do, cannot be standardized,

nor is it possible for the management to prophesy six to nine months before the beginning of the fiscal year how its general expense money appropriation should be distributed. As evidence of this, I present the following analysis of our expenditures for the fiscal year 1914–15 and the expenditures from July 1, 1915, to June 30, 1916:

	1914–15	1915–16
Fuel, light, power and water	$4,031.37	$2,753.52
Printing	401.68	94.07
Equipment		
Office	46.43	428.34
Motor vehicle	....	625.00
Research	2,786.57	4,394.65
Farm and garden	2,391.99	1,618.78
Books	1,250.35	857.80
General plant	....	15.00
Livestock	7.00	....
Wearing apparel	56.20	....
Total	$6,538.54	$7,939.57
Supplies		
Office	1,340.28	1,009.56
Laundry, cleaning and disinfecting	52.80	79.83
Motor	371.77	460.78
Research	1,739.61	1,822.94
Botanical and agricultural	4,069.97	4,734.92
Forage and veterinary	861.07	995.94
General plant	1,119.63	467.50
Household	25.96	....
Total	$9,581.09	$9,571.47
Hired horses and vehicles	$3,028.29	$2,417.41
Traveling expenses		
Transportation	1,888.59	1,697.95
Hotel	1,998.07	1,361.85
Total	$3,886.66	$3,059.80
Communication	1,755.44	2,358.23
General plant service	3,166.74	1,023.71
Rent	1,291.29	961.62

The foregoing figures show how absurd it is in the management of an institution of this character to base the distribution of funds for a future fiscal year upon what has happened during a year that has past. The present year affords an admirable illustration of situations which may be encountered in any year. The expenditure for coal is an important item with any institution and the price of soft coal has increased from a little over $2.00 a ton to $5.50. With a fixed item for fuel, what can an institution do? If some

relief from such a fiscal policy is not arrived at through a better understanding of the situation, not only will the autonomy of the management of the institution be seriously limited but it will be impossible to administer funds efficiently. This matter is not presented in the way of criticism, but is a frank and necessary discussion of a situation which the Experiment Station is obliged to meet.

THE NEW BUILDING

It is fitting that grateful acknowledgment should be made to the Governor and Legislature for the appropriation of one hundred thousand dollars with which to erect an administration, library and demonstration building. According to plans which are practically completed and which have had the approval of your Building Committee, this building will contain the administrative offices, a library, two audience rooms, one with a seating capacity of approximately six hundred persons and another with seating capacity of one hundred, and museum space. This building is to be of essentially fire-proof construction. According to the vote of your Board, it is to be located on the north side of North Street, facing the space between the present administration building and the biological building. This location has been made possible through the purchase of a lot of land with 250 feet frontage, running back 225 feet. This area will give an admirable opportunity for giving the building a setting of trees and shrubbery.

FURTHER BUILDING NEEDS.

The Legislature of 1916 was asked to furnish means for the erection of new plant houses and a cold storage house. The reasons for this request may be restated in language used in my report for 1915:

" The time has come when in order to carry on its work with the desired efficiency new and greatly enlarged plant houses should be provided. The present plant houses of the Station were erected about twenty-five years ago. They have exceeded the usual life of such structures, and are now neither adequate nor efficient. There is a large amount of work in agricultural investigation which should be carried on in such houses, if carried on at all, including plant breeding, plant nutrition and studies of plant diseases and

injurious insects, to all of which lines the Station is obliged to give much attention.

"The small cold-storage house, established chiefly for the storing of fruits, was erected at the Station something more than twenty years ago. The preservation of fruits, of which the Station has several thousand varieties, requires cold storage facilities in order that such materials may be used for study and exhibition purposes. The present cold-storage plant is inadequate in size and construction and if retained will need enlargement and extensive repairs. A new building should be erected."

It is not to be expected that an institution which has been in operation for thirty-four years should not find it necessary to replace buildings of a somewhat perishable character that have been in use during that time. The State must either provide the means for such replacement or allow the institution to deteriorate seriously in appliances and efficiency.

ACQUISITION OF MORE LAND.

In my last report, attention was called to the great desirability of acquiring for this institution a tract of land on the east side of Castle street, adjacent to the Station property, of about twenty-three acres. The owner of this land, with fine public spirit, has refrained for several years from breaking it up into building lots because of his desire that it shall become the property of the State, as an adjunct to the Experiment Station. This land is needed in order to establish upon it not only an arboretum for the study of ornamental trees and shrubs but for the establishment of a collection of the progenitors of our fruit trees and shrubs as a means of promoting the study of plant breeding work which this institution is carrying on very extensively and, as we believe, to the great benefit of the horticulture of the State. More money could be realized for this park by disposing of it in a commercial way. The owner has been willing to delay offering it to the public for building purposes in order that opportunity may be given for the Legislature to take the necessary steps to acquire it for Station purposes. It is hoped that the Legislature will not commit so great a mistake as to allow this land to be absorbed for other purposes.

STATION PUBLICATIONS.

The distribution of Station publications is in accordance with the following figures:

POPULAR BULLETINS

Residents of New York	38,898
Residents of other States	2,408
Newspapers	777
Experiment stations and their staffs	2,318
Miscellaneous	100
Total	44,501

COMPLETE BULLETINS

Experiment stations and their staffs	2,318
Libraries, scientists, etc.	401
Foreign list	332
Individuals	3,965
Miscellaneous	100
Total	7,116

It is easily seen that not over one-fifth of the farm owners of the State are receiving the Station bulletins. If this were the only way in which the results of the Station's investigations were disseminated, the situation might seem discouraging. As a matter of fact, however, information based upon the knowledge which the Station staff is able to acquire through its researches is spread among the people of the State in various other ways, as, for instance, through instruction in the class-room at the College of Agriculture and the agricultural schools, through imitation by his neighbors of what a farmer or fruit grower accomplishes through the application of new knowledge, through the activities of county agents and institute schools and through the rural press. It is indeed a worthy result to educate a young man for usefulness in some walk of life, but it is even a greater thing to accomplish to develop a new truth which in all time and among all people promotes human welfare. It would be a serious mistake to suppose that the dissemination of any new knowledge is limited numerically by the mailing list of any institution whatever.

There is presented this year as a part of the annual report of the Station, manuscript of another fruit book to be known as "The Peaches of New York." I can assure your Board that this publica-

tion will surpass in artistic features and in thoroughness of preparation any one of the four previous publications which have been issued.

The fruit growers of the State should bear in mind that, if the present regulations of our printing department are maintained, 5,000 copies of this report will be absorbed by members of the Legislature, 2,000 copies will go to the Commissioner of Agriculture and only 2,000 copies will be available by the Station itself to meet the demands made upon it. The popularity of these publications with the resultant extensive demand for them has often placed the Station in an awkward position because of the number of requests which it has been obliged to refuse for some one of these publications.

POLICY TO BE APPLIED TO STATION ACTIVITIES.

The question of the policy which an Experiment Station shall follow in the selection of its work is an ever recurring one. This selection generally lies between a close scientific study of facts or principles which underlie agricultural practice or efforts of a more popular character which relate quite directly to practice. Doubtless the latter line of endeavor is more likely promptly to secure a popular verdict and increased good will toward the Station among its constituency than the former.

The great value of past investigations of the severer sort is well illustrated in many directions, as for instance by a study of the relation of germ life to leguminous plants, the discovery of the useful nitrifying organisms of the soil, the relation of certain compounds to the maintenance of plant life, investigations concerning the functions of certain nutrients in the development and maintenance of animal life and the underlying chemical and biological factors which are important in dairy technology. The great benefits that have been derived from these and many other researches of the same general character are too evident to be denied. Work of a more popular character may be illustrated by tillage experiments, fertilizer tests, comparisons of rations, and illustrative experiments in spraying and along other phases of farm practice. Work of this latter kind may properly be classed as demonstration or extension work.

A close study of Station activities in the United States leads to the conviction that a large percentage of the energy and resources

of these institutions has been expended in dealing with the immediately practical side of farm problems. In other words, much so-called investigation or experimentation has dealt with variables, that is, with matters that are of only relative importance and that have no fundamental and general relation to any phase of farm practice. Without question, Experiment Stations have busied themselves to a great extent with problems that are simply business factors in farm management and which must be settled by the farmer himself as an essential part of his business operations. It is for these reasons that we have a large mass of Station literature that is rapidly disappearing from our attention — simply because it added nothing of a permanent character to agricultural science. Doubtless the institution under your care has been guilty of transgressions of this sort.

It is safe to assert that individual farmers have often been misled through giving them advice based upon circumstances in other localities and under other conditions. Within certain limitations the farmer must be left to work out his business salvation, and the influence of any outside agency must be introduced with great caution. The observation is pertinent in this connection that Experiment Stations are seriously in error when the results of their studies, whether in the field or elsewhere, are given in terms of dollars and cents. If there are good reasons for conducting a field experiment where the yield of different plats treated in an unlike manner is compared, it is not rational to say that one plat gave a profit of six dollars more than another plat, because the six dollars is a variable which might be some other figure with labor and supplies having a different cost and the product selling at a different price. Measurements of this kind should be in units of production.

In the former statements it is not intended to condemn so-called practical experiments. They are valuable adjuncts to research. It is often necessary to do field work in order to determine the applicability of a theory or a suggested practice, sometimes in the field, sometimes in the orchard and sometimes in the cheese factory or dairy. Many problems have two phases, the underlying facts or principles and the application of these facts or principles, and the application can only be studied by entering into practice.

INSPECTION WORK.

The inspection work of this institution includes the examination of Babcock glassware and agricultural seeds.

The number of seed samples examined is as follows:

Official samples	569
Samples sent by farmers and other correspondents	775

The following figures show the pieces of Babcock glassware examined:

Milk bottles	21,839
Cream bottles	5,492
Pipettes	4,003
Skimmilk bottles	330
Acid measures	728
Total pieces inspected	32,392
Rejected from milk and cream bottles	141
Rejected from pipettes	43

The data in regard to the examination of samples of fertilizers and feeding stuffs are given under the head, " Department of Chemistry."

RESULTS OF STATION WORK ACCOMPLISHED IN 1916.

The Experiment Station has published 15 bulletins and 9 technical bulletins covering the work of the institution during the year 1916, including those which report the inspection of fertilizers and feeds. Of these bulletins 8 have been reproduced in popular or summarized form. There follows a brief summary of Station work for the year consisting mainly of certain of the principal data presented in these bulletins:

DIVISION OF AGRONOMY.

FIELD WORK DONE OUTSIDE OF STATION FARMS.

Alfalfa and sweet clover culture on southern New York hill lands:

L. Gallagher, ($\frac{1}{2}$ acre), Oxford.
C. G. Baker (2 acres), Chenango Forks.
H. G. Skinner, Jr. (1 acre), Prattsburg.
A. S. Matherny (1 acre), Binghamton.
W. P. Mead & Son (4 acres), Jamestown.
A. R. Chappel (2 acres), Sidney.
W. D. Carey ($\frac{1}{2}$ acre), Watkins.
Earl D. McGilliard (2 acres), Penn Yan.
F. A. Wigsten (1 acre), Elmira.

Apple orchards: Fertilizer, cultivation and cover-crop tests:	**Great Bear Springs Co. (8 acres), Fulton.**
	R. B. Densmore (8 acres), Albion.
Cherry orchard: Fertilizer cultivation and cover-crop tests:	**P. F. O'Neil (3 acres), Geneva.**
Pear orchard: Fertilizer, cultivation and cover-crop tests:	**Lawrence Howard (3 acres), Kinderhook.**
Vineyards: Fertilizer and deep-plowing tests:	**S. E. Stone, Jr. (4 acres), Fredonia.**
	D. W. Blood (2 acres), Dunkirk.
Tobacco-culture experiments:	**F. A. Tuerk (12 acres), Baldwinsville.**
	B. I. Crego, Baldwinsville.
Hop-culture experiments:	**P. R. Bennett (6 acres), Milford.**

BACTERIOLOGICAL AND DAIRY DIVISIONS.

The chief attention of the members of these divisions has been given to the study of problems connected with stable and milk sanitation, and to a study of soil micro-organisms.

The sanitary milk problems which have been given the greatest attention are: (1) Methods of controlling the sanitary quality of market milk; (2) the importance of the machine milkers as a source of bacteria in market milk; and (3) the accuracy of methods of bacterial analysis of milk.

(1) *Methods of controlling the sanitary quality of market milk.*— During the past two years, the Station has undertaken the sanitary inspection and control of the greater part of the milk supply of the City of Geneva in order to test out the value of the methods of control which have been developed in connection with the experimental work. By agreement with the two local milk companies, the dairymen and the local and state boards of health, the Station has undertaken a laboratory inspection of the milk received at the two milk stations and the findings have been used as a basis of payment to the dairymen and as a means of controlling the milk supply. The information secured from the laboratory analyses has been supplemented by that secured from visits to the farms. Special analyses have been made in order to discover the sources of trouble wherever time permitted or there were indications that the results would be valuable. In this way the findings from the studies made at the Station have been compared and contrasted with conditions met with in the field. A preliminary report on this work will be ready for publication during the coming year.

(2) *The influence of various barn factors upon the bacteriological quality of milk.*— The particular phase of this general problem which has occupied the attention of these divisions during the past year has been the importance of machine milkers as sources of bacteria in milk. The work has progressed far enough to show that they, like other dairy utensils of similarly complicated construction (bottlers and the like), are ordinarily the sources of a very large bacterial contamination of milk. Methods of cleaning and sterilizing these machines are now being studied and it has been found that they can be completely sterilized (except for an insignificant contamination from the air) by using steam for the metal parts and a solution of chloride of lime for the rubber parts. It is believed that the methods used are capable of being so simplified that results very nearly as good can be obtained by any intelligent farmer. The next experiments made will be carried out in an effort to determine whether or not this belief is justified.

The value of having joined efforts with the Illinois Station in this general study of the sources of the bacterial contamination of milk has been shown by preliminary publications from the latter Station during the past year dealing with the importance of dairy utensils as causes of trouble and of publications which corroborate the findings previously published from this Station in regard to the relative unimportance of dust in the stable air, special methods of wiping the udder and of cleaning the cows, and interior finish of the stable as sources of bacterial contamination of milk. As a result of all of these studies upon stable sanitation, a trial form of dairy score card has been drawn up which is now being used at the Illinois Station in a practical way in order to determine its value.

(3) *The accuracy of present methods of bacterial analysis of milk.*— The increasing use of the bacterial count in this State as a means of grading milk makes studies of the accuracy of the results highly desirable. From the beginning bacteriologists have recognized the great difficulties involved in getting an accurate count of objects as minute as bacteria, especially as these occur at times in incredible numbers. The methods which have been used in making these counts have been indirect ones based upon the growth of the bacteria into colonies visible to the naked eye. It has been recognized that there were certain possible errors in the counts which would tend to make the numbers too low; but no method of measuring the amount

of the errors has ever been devised until recently. The errors have been controlled as well as could be done by the adoption of standard methods of analysis and the counts secured have agreed fairly well when made by trained workers using satisfactory methods of analysis.

The common use of this technique in control and commercial laboratories, where tens of thousands of samples of milk are handled yearly, has, however, caused various modifications and simplifications of the methods of analysis to be brought into use and the question has arisen whether the results secured are accurate enough so that the farmer and dealer can depend upon them. As a result, this Station joined with four New York City laboratories in carrying out the most extensive series of comparative analyses which has ever been attempted; and the findings were published by the U. S. Public Health Service in Public Health Reports for August 13, 1915. These findings were not altogether reassuring to the farmers and dealers and showed the necessity for further studies. These, the Station has undertaken both at Geneva and also in cooperation with the Department of Dairy Industry of the State College of Agriculture and the work is in progress at the present time. A discussion of one of the sources of error has been published during the year as Technical Bulletin No. 53.

The recent development of microscopical methods of counting bacteria in milk (the work having been done largely at this Station) permits comparative analyses to be made from which it will be possible to determine the amount of the errors in the count and their causes much more accurately than has ever before been possible. A description of this method of counting has been published during the year as Technical Bulletin No. 49. A description of the technique has also been incorporated in the report of the official standard methods of bacterial milk analysis adopted tentatively by the American Public Health Association.

Soil flora studies.— In spite of the advances in knowledge regarding the microorganisms which live in the soil, no comprehensive attempt has been made to classify the microorganisms therein or to learn their relative abundance and distribution. The Station has been undertaking this work for the past five years and two technical bulletins dealing with certain phases of the studies have been issued during the past year. A general report discussing all of those

organisms which can be studied by the ordinary bacteriological methods is now being prepared and will be issued in a series of technical bulletins. The results secured indicate that the methods used have probably disclosed the larger part of the most important soil organisms, though this is far from being certain. Three main groups of organisms have been recognized: (1) Long, rod-shaped, spore-forming bacteria, (2) a group of organisms sometimes regarded as bacteria and sometimes as true fungi, known technically as Actinomycetes, and (3) the group of non-spore-forming bacteria. In Technical Bulletin No. 51, it has been shown that, while the spore-forming bacteria are always present in soil, forming about 5–10 per ct. of the colonies on agar plates, there is good reason for believing that they exist in normal soil only as spores and that they are therefore not ordinarily active in soil. This finding is contrary to what has generally been assumed, as it has been thought that they were active ammonifiers in soil and therefore very important agents in the decay of organic matter in the soil. The Actinomycetes have been found to be more abundant in sod soils than in cultivated soils (Technical Bulletin No. 52), ordinarily forming about 30–40 per ct. of the colonies on plates from sod soil and only 15–30 per ct. of the colonies from cultivated soil. Because of their association with grass roots, it has been suggested that they are the organisms which are active in causing the decay of dead grass roots. A study of the classification of these organisms has thus far revealed a surprisingly large number of different types, about 70. New methods have been developed for this study which it is hoped will permit a satisfactory classification of them to be made. Further knowledge of this obscure and little known group, which apparently is very important in soil activities, is greatly needed. It is the group which contains the organism causing potato scab as well as some organisms which cause diseases of animals, one of the more important of which, from the agricultural standpoint, is the one causing lumpy jaw of cattle. The group of non-spore-forming bacteria has been found to be the most abundant of all bacteria in soil, apparently the most active, and therefore probably the most important of all. However, thus far they have proved to be very difficult to study in any way which will show how many kinds there are or what their function is in soil. No methods have yet been devised which give any real knowledge in regard to these points.

COOPERATIVE STUDIES

Stable and milk sanitation................	Illinois Agricultural Experiment Station, Urbana, Ill.
Methods of counting bacteria in milk.......	State College of Agriculture, Ithaca, N. Y.
Methods of controlling the sanitary quality of market milk........................	White Springs Farm Dairy Co., Geneva Milk Company, Geneva Board of Health, and about 40 dairymen in the vicinity of Geneva.

BOTANICAL DIVISION.

Tree crickets as carriers of parasitic fungi.— In earlier work of the Station it has been shown that the areas of dead bark surrounding the oviposition punctures of tree crickets on apple branches are often caused by the fungus of raspberry cane-blight, *Leptosphaeria coniothyrium*. Naturally, the suspicion arose that tree crickets carry the spores of the fungus. This suspicion has now become an established fact. It has been shown that they may carry the cane-blight fungus from raspberries to apple trees and infect them; also that they carry within the digestive tract and on the outside of their bodies spores of many other kinds of fungi. Spores and fragments of mycelium of many kinds of fungi have been found in the excrement of tree crickets captured in the field and in the excrement covering their oviposition punctures.

By means of feeding experiments it has been proven that the spores of fungi causing such diseases as corn smut, raspberry cane-blight and the blister canker and black-rot canker of apple trees may pass through the digestive tract of tree crickets without loss of viability. Also, typical apple cankers have been produced by feeding tree crickets on raspberry cane-blight fungus and then permitting them to oviposit on apple branches.

This work was done in cooperation with the Entomological Division. The results have been published in Technical Bulletin No. 50.

Lime-sulphur solution versus *bordeaux mixture for potatoes.*— Each summer during five consecutive years an experiment was made in which lime-sulphur solution and bordeaux mixture were compared as to their efficiency in the spraying of potatoes. The bordeaux mixture proved superior in every case. Its use resulted in an average increase in yield (over the check) of 68.6 bushels of marketable tubers per acre; while from the use of lime-sulphur solution there

was an average *decrease* of 25.8 bushels per acre. In all five seasons the lime-sulphur solution caused injury to the foliage. Only in the last season of the experiment was there an opportunity to test the effect of the two mixtures on late blight. Bordeaux mixture checked it very materially but lime-sulphur solution not at all. Clearly lime-sulphur solution should not be used for spraying potatoes.

The degeneration, or "running out," of potatoes.— The so-called "running out" of potatoes is usually due to certain obscure diseases or forms of degeneration known as leaf-roll, curly-dwarf, mosaic and spindling-sprout. For the purpose of increasing our knowledge of these diseases a large number of potato plants of known parentage were kept under close observation.

One striking feature of the study was the frequency with which the progeny of plants having normal foliage and high yield suddenly degenerate into worthless dwarfs affected with some one of the diseases above named. From this it appears doubtful if any method of seed selection will prevent the "running out" of potatoes under certain conditions.

In general, plants from different tubers of the same plant are similar; also plants from different eyes of the same tuber usually resemble each other closely; but exceptions to both rules are frequent. Various combinations of normal, mosaic, leaf-roll and curly-dwarf plants may be obtained from the several eyes of one tuber.

Although the cause of none of the diseases was determined, the conclusion was reached that leaf-roll, mosaic and curly-dwarf are very closely related disorders. All three are transmitted through the seed tubers, and, apparently, are not communicated in any other way. Spindling-sprout is not correlated with the other diseases. Whether this, also, is an hereditary disorder has not been determined.

Field work.— An experiment on the mosaic disease of potatoes, is being conducted on Mr. Sirrine's farm at Riverhead in cooperation with Mr. W. A. Orton, of the United States Department of Agriculture.

CHEMICAL DIVISION.

Chemical changes in souring milk.— In studying the chemical changes that take place in the souring of milk, it is found that in 60 hours about 22 per ct. of the milk-sugar is changed by the lactic acid bacteria, 88.5 per ct. of the amount so changed being converted into lactic acid. Citric acid completely disappears. The insoluble

inorganic constituents of the fresh milk are made soluble by the lactic acid, the latter passing into combination mainly as calcium lactate. Albumin of sour milk passes through a porcelain filter completely. Calcium caseinate is changed into free protein and precipitated. Most of the change of milk-sugar occurs between the 10th and 24th hours. When the amount of lactic acid reaches 0.7 per ct., the bacterial activity is much reduced. The acidity increases most rapidly during the first 24 hours, the rate of increase diminishing after that. The acidity of the serum increases, owing to increase of lactic acid. In the insoluble portion of the milk the acidity is due to free casein. Calcium, combined as dicalcium phosphate in milk, goes into solution completely in 13½ hours, forming acid calcium phosphate. Calcium combined as caseinate is acted upon more slowly, complete solution requiring about 24 hours. The amount of albumin nitrogen in serum increases with increase of acidity; all the albumin of the milk appears in the serum in about 14 hours. These investigations are discussed in Technical Bulletin No. 48.

The utilization of inosite by the animal organism.—Phytin is a somewhat important compound found in our cereal grains, of which inosite is a constituent part. In studying the rôle of this inosite-bearing body, it seemed desirable to determine the fate of inosite itself in the animal organism.

Experiments with dogs showed that inosite is not used by this animal to any great extent.

When taken by man at the rate of a half gram per kilogram of body weight, it had no effect upon the general metabolism. About nine per ct. of it appeared in the urine, but none in the feces. Just what happened to the 91 per ct. not eliminated through these two channels was not determined. For details of these experiments those interested are referred to Technical Bulletin No. 54.

A study of the volatile oils in the urine of cows, goats, horses and human beings.—The volatile oils that may be isolated from the urine of the several species of animals, including man, have been investigated comparatively little.

Such oils, as isolated from the urine of the animals mentioned in the heading, have been given considerable attention in our laboratory and progress made in determining their chemical nature. They appear to vary with the season and the available food supply. Discussion of these studies appears in Technical Bulletin No. 55

Inspection analyses.— During 1916, 650 samples of fertilizers were analyzed. There were 234 samples of complete fertilizers; 218 samples of mixed fertilizers, containing nitrogen and phosphoric acid; 70 samples of acid phosphate; 28 samples of calcium or lime compounds; 32 samples of bone; 15 samples of tankage; 10 samples of nitrate of soda; 10 samples of dried animal manures; and a small number of samples each of blood, dissolved bone, mixtures of phosphoric acid and potash, insoluble phosphoric acid materials, ashes, garbage tankage, ground fish, soot, stone-meal, mixtures of nitrogen and insoluble phosphoric acid; and mixtures of calcium compounds and phosphoric acid.

During the year 1916, 1015 samples of feeding-stuffs were analyzed. There were 45 samples of cottonseed meal, 13 of linseed meal, 13 of malt sprouts, 14 of distillers' dried grains, 5 of yeast or vinegar dried grains, 11 of brewers' dried grains, 12 of corn gluten feed, 1 of corn gluten meal, 29 of hominy feed, 117 of compounded feeds, 132 of molasses compounded feeds, 95 of compounded poultry foods, 12 of calf meals, 54 of animal products, 23 of alfalfa meal, 130 of wheat bran, 114 of wheat middlings, 65 of wheat bran and wheat middlings, 8 of wheat bran and low-grade wheat flour, 60 of buckwheat products, 3 of ground corn and oats, 7 of wheat bran and corn by-products, 3 of wheat middlings, rye middlings and ground screenings, 13 of corn feed meal, 15 of rye by-products, 5 of ground screenings, and 18 of miscellaneous mixtures.

ENTOMOLOGICAL DIVISION.

Plant lice injurious to apple orchards.— Injurious as are several species of aphides to apple orchards, there was, prior to this study, a lack of detailed information as to their activities as fruit pests and of practical measures for the prevention of losses to fruit yields. Of the three aphides that attack apple foliage and fruit the rosy aphis (*Aphis sorbi* Kalt.) is the most injurious species, although the associated forms, the green apple aphis (*Aphis pomi* De Geer) and the oat aphis (*Aphis avenæ* Fab.) are capable of causing harm. The rosy aphis, when abundant, produces small deformed apples commonly known to orchardists as "aphis apples" which for the most part have no value. Studies on the life history and habits of this species show that it breeds on apple trees during May, June and early July. During the two latter months winged forms are

produced which migrate to various species of plantains. On these weeds the rosy aphis exists until autumn when it again seeks apple trees. Experiments with the insect to determine its influence on the development of the young fruit indicated that inhibition of the growth of the apples varied largely according to the extent of infestation. In general the rate of development was in inverse proportion to the degree of infestation — the larger the number of aphides the smaller the size of the affected fruit. Of forty-nine apples exposed to attack by the rosy aphis only two fruits were at the end of the growing season of marketable size and shape, while many of the apples besides being undersized were also one-sided or otherwise deformed. All checks, thirty-one in number, were normal in shape and ranged from 2¼ to 3⅜ inches in diameter. Besides the obvious shrinkage in fruit yields from the so-called "aphis apples" it is apparent from these figures that growers may sustain more or less important losses from attacks of the insects which, while not serious enough to render apples unsalable, nevertheless prevent them from attaining maximum size.

On the basis of experiments conducted by this Station the most promising means of combating the aphides is a thorough spraying of the trees at the time when the insects are assembled on the ends of the buds showing green and while the buds are compact and the tips of the unfolding leaves are barely showing. Complete directions for the spraying of apple trees as well as an account of the results of the biological studies to date are given in Bulletin No. 415 of this Station.

Cabbage maggot: Biology and control.— Bulletin No. 419 contains the results of studies on the life history and habits of the cabbage maggot for a period of eight years and data on the effects of weather and of different crops on its numbers as well as on its susceptibility to certain control measures. The cabbage maggot is a northern insect and, like its host, attains maximum development in a cool, moist climate. Studies on the life history of the pest show that when conditions are favorable there are at least three broods and perhaps a partial fourth brood. However, the summer temperatures that frequently occur during July and August in western New York are unfavorable to the normal development of the insect, and seem to cause a retardation which may last until the weather becomes cool. High temperatures affect the insect both directly and indirectly.

The roots of cabbage and other cruciferous plants become tough and woody at the appearance of hot weather, so that the larvæ grow very slowly. Also, it appears that the weather may directly influence the pupal stage and that this period may be lengthened or shortened so that the insect may be one-, two- or three-brooded. This situation has been interpreted in the same way as that outlined by various writers for the Hessian fly, which is, namely, that high temperature or severe drought causes a retardation of the developing larvæ and pupæ. It is probable that the optimum temperature for the development of the pupæ is around 80° F. for the average maximum temperature and 55° for the minimum.

The control work has been mainly directed to perfecting the method of growing cabbage seedlings under cheesecloth for the protection of young plants in districts devoted to the cultivation of late varieties of cabbage. In localities where injuries are confined to seed-beds the use of cheesecloth has proven a practical and economical means of preventing loss. In addition to protection from injurious insects cheesecloth helps to conserve the moisture and prevents the soil from becoming encrusted. Plants raised in screened beds grow faster during most seasons and attain the size desired for transplanting sooner than plants in open beds. The extra cost of protecting plants by this method ranges approximately from six to twenty cents per thousand, and in the opinion of farmers this additional outlay is more than met by the saving in seed over the old method of growing seedlings. For the protection of early cabbage tar pads attached about the collars of the plants have proven the most efficient and economical method for the prevention of losses.

Miscellaneous notes on injurious insects.— Bulletin No. 423 deals briefly with a number of insects which are generally of minor importance, though certain of them reveal harmful potentialities; and other species are sufficiently numerous in occasional years to cause considerable damage. The most important species discussed are the orchard ermine moths (*Yponomeuta malinellus* Zell. and *Y. padellus* L.) which are very destructive fruit pests in Europe. Especial importance is attached to the insects at this time since, in spite of previous warnings by this Station, they are being introduced in greater numbers than ever before. The largest importation in a single year was noted in 1915 when over three thousand seedlings infested with ermine-moth nests were detected in more than a

dozen localities widely distributed in the fruit regions of western New York. As there is danger of the permanent establishment of these pests, horticultural inspectors and fruit growers alike should be alert to the importance of recognizing and combating them on their first appearance. Observations on the larval activities on apple are in accord with those of foreign writers upon the species attacking this host. The leaf-weevil (*Anametis granulata* Say) is recorded as being present in destructive numbers in plantings of young peach trees in Niagara County. The insects ate opening buds and margins of unfolding leaves. Injurious outbreaks are also noted for the lesser peach borer, the linden cankerworm and the gooseberry fruit-worm. In an effort to correlate the different green fruit worms on apple with the moths of the various species, one form (*Graphiphora alia* Guenée), which belongs to a group not known heretofore to contain noxious insects, proved to be quite common and destructive to young apples.

Leaf weevil (*Polydrusus impressifrons* Gyll.).— Technical Bulletin No. 56 is an account of an imported species of leaf-weevil which was recently discovered in the State of New York where, in certain localities, it has become very abundant. The beetle apparently manifests a choice for willows, poplars and birches. It causes damage to plants by nibbling the developing buds of budded and grafted stock and attacking the foliage and succulent tissues, as stems of newly-unfolded leaves and stalks of terminal growth. The gouging of tender tissues is not infrequently attended by severing of leaves and destruction of tips of shoots. The life stages and habits of the beetle have been carefully studied and are described for the first time with considerable detail. The weevil is attacked by at least one parasite, which proves to be a new species of braconid of the genus *Diospilus* Haliday. Protection from the leaf-weevil is obtained by applications of arsenicals at standard strengths.

Cherry leaf-beetle.— This species, which suddenly developed to enormous numbers during 1915 and 1916 and seriously attacked various stone fruits, principally the cherry, is the subject of Circular No. 49. This is a popular treatise, illustrated with two plates, in which the different stages are described and figured and the seasonal history is discussed. On the basis of some preliminary experiments by this Station, brief directions are given as to the most efficient methods for the prevention of injuries.

Periodical cicada in 1916.— Circular No. 50 was prepared to notify orchardists of the probable occurrence of the cicada during 1916 and to solicit information as to dates of appearance, distribution and local importance. The chief point of interest noted in the reappearance of the species was the occurrence of great numbers of the creatures in old apple orchards generally, growing north of Victor, where considerable damage was done to both apples and peaches as a result of oviposition.

Some insects attacking the pear and their control.— Circular No. 51 was originally prepared for a publication for the New York State Department of Agriculture and was reprinted by this Station without change in text. It is a brief compendium, dealing with the more destructive insects of the pear, in which chief emphasis is placed on such species as the sinuate borer, the pear thrips and the pear psylla.

COOPERATIVE EXPERIMENTS.

NATURE OF ACTIVITY.	COOPERATOR.	LOCATION.
Control of pear thrips	A. W. Hover & Bro	Germantown.
	W. Ten Broeck	Hudson.
Control of pear midge	W. Ten Broeck	Hudson.
Control of pear psylla	Oswego Co. Farm Bureau, E. Victor Underwood, Mgr	Oswego.
	David Enos	Oswego.
	Eugene Sheldon	Oswego.
	Frank Place	Oswego.
	C. E. Dexter	Oswego.
	Oliver Robarge	Oswego.
	H. Barnhardt	Oswego.
	James Bremner	Oswego.
	William Ruttan	Oswego.
	John Crites	Oswego.
	Ralph Pierce	Oswego.
	F. Prosser	Oswego.
	W. H. Clift	Oswego.
	D. A. Griswold	Oswego.
	D. D. Stone	Oswego.
	W. S. Rappelye	Oswego.
	E. J. Lonis	Hannibal.
	W. E. Hall	Hannibal.
	E. B. McGlen	Hannibal.
	Middlewood Farms	Varick.
	C. S. Baldridge & Son	Kendaia.
	Van Epps & Sanford	Geneva.
	Fred Hammond	Geneva.
	Charles Young	Geneva.
Control of sinuate pear borer	Westchester Co. Almshouse	Eastview.
	H. H. Brown	Monsey.
	I. V. S. Duryea	Monsey.
	Gustave Schwab	Ossining.

NATURE OF ACTIVITY.	COOPERATOR.	LOCATION.
Control of apple aphides....	E. S. Gifford....................	Gasport.
	G. D. Tabor....................	Wilson.
	B. S. Harwood..................	Appleton.
	F. L. Backus....................	Olcott.
	H. H. Freeman..................	Kent.
	John Larwood...................	Albion.
	John Beckwith..................	Lyndonville.
	H. B. Gibson....................	Albion.
	G. E. Snyder....................	Albion.
	Lynn Burrows..................	Albion.
	John Beckwith..................	Demster.
	Mrs. Ida Lafler.................	Albion.
	Maxwell Bros..................	Geneva.
Control of cherry aphis.....	McKay Bros....................	Geneva.
Control of cranberry scale...	R. C. Brown....................	Riverhead.

HORTICULTURAL DIVISION.

New or noteworthy fruits. IV.—All interested in better fruits should welcome new varieties. No one of our fruits is yet perfect; and, until perfection be attained, new varieties, better in one or more characters, are well worth their cost for the progress they make in the development of fruit. If the multiplication of kinds helps to evolve more perfect fruits, what matter if many, even most, new fruits turn out to be unprofitable in dollars and cents? The little time and expense needed to apply the test of fitness to a new fruit is a cheap price to pay for the development of better fruits. Again, there is profit in growing many varieties for variety's sake. In the business of growing fruit a multitude of varieties is needed for a multitude of consumers; dessert and culinary requirements are many and are not nearly met by the niggardly assortment which commercial fruit-growers are now putting on the markets. A greater variety from which to choose would further the enjoyment and the consumption of fruits.

Unfortunately, neither time nor money suffices for the fruit-grower to determine for himself the merits of all of the new fruits. This Station attempts, as far as it is able, to do this for him, and from year to year bulletins are published to show what fruits on the Station grounds, either novelties or old sorts now neglected, are sufficiently noteworthy to deserve the attention of fruit-growers. In Bulletin No. 414, the fourth in this series, are discussed the Perfect apple, Rochester peach, Reine Hortense cherry, Empire State grape and Herbert raspberry.

New or noteworthy fruits. V.— In Bulletin No. 427 is given a fifth report on new or noteworthy fruits grown on the grounds of the New York Agricultural Experiment Station. The purpose of this series of bulletins is to call attention to the best recent fruit-introductions or to an old, deserving variety of merit at present but little grown. In the introductory remarks emphasis is laid on the fact that varieties do not grow equally well in all soils and climates, and that a sort succeeding in one place may fail in another locality. The objects of growing many varieties on the Station grounds are: To make certain whether each is distinct; to tell relative time of blooming, leafing, ripening, and maturity of plant; to determine earliness or tardiness in coming in bearing; to ascertain, to some extent, susceptibility to insect and fungus pests; to determine for what purpose varieties are best adapted; to make full and complete descriptions for purpose of identification; to make it possible to state what varieties succeed on the soil, under the climate and with the treatment given them on the Station grounds. Report is made of the number of fruits growing on the Station grounds.

Following this discussion various fruits thought to be worthy of attention are described. These are the J. H. Hale and the Pearson peaches, the Mirabelle plums, the Empire raspberry and the Good Luck strawberry.

Some notes on the breeding of raspberries.— Bulletin No. 417 discusses some of the results secured in nearly a quarter of a century of raspberry breeding at this Station. At first the work was largely confined to the red raspberry and a number of excellent seedlings was secured from various combinations of Marlboro, Loudon and Superlative. Since 1910 greater attention was paid to the black-cap and purple raspberries. About 3,300 seedlings were tested. The breeding of purple raspberries was undertaken to secure better varieties of this popular sort and to show, beyond a doubt, that these originated as hybrids of the black-cap and red raspberry. Some very promising seedlings have been secured. Hybrid seedlings were produced by crossing two different black-caps with the same red raspberry. With one cross the seedlings were all purple; among the 289 seedlings of the other cross were ten yellows. None propagated by suckers.

In order to find which are the best parents, a study was made of the performance of various varieties. The record of Marlboro,

Herbert, Cumberland and Smith No. 1, a seedling black-cap of unknown origin, is given.

A study of the inheritance of color of fruit would indicate that several of our black raspberries are heterozygous for color and that probably several color factors are present. The same thing holds for the red raspberries. Selfed seedlings of Columbian, a purple, gave one yellow, one black and forty that were probably varying degrees of purple. A black-cap which was pure for color produced only purples when crossed with a red containing a factor for yellow but, when both were heterozygous, some yellow hybrids were produced. From a correlation which was found between leaf coloration and fruit it would seem that it is entirely possible to tell plants of the yellow raspberries from either the red or purple sorts by the absence of any tinge of red on the leaves. It is probably true also that the bark of the young canes of the yellow varieties is entirely lacking in any touch of red or purple color. Glaucousness, rough and smooth bark, and spines are seemingly Mendelian characters.

Of more than 600 purple raspberry seedlings having Smith No. 1 as the female parent, all were standard plants; but nearly one-third of the 289 Cumberland seedlings were dwarfs. The factor for dwarfing is evidently one of rather rare occurrence.

Some interesting hybrids were secured when the Herbert red raspberry and the Blowers blackberry were pollinated by the flowering raspberry, *Rubus odoratus*. This work of hybridization will be continued with many other species, of which there are now nearly fifty growing on the Station grounds.

Witloof chicory. — This is a salad plant little grown in America but of wide and extended use throughout Europe. The leaves forced from the dormant roots by application of artificial heat constitute an excellent salad material for use during the winter season. Large quantities were imported into this country from Belgium and France previous to the war.

Bulletin No. 418 reports the results of studies at this Station of the culture and forcing of Witloof chicory. It was found that plants may be easily grown from seed under our usual garden environment. Roots of a diameter between one and two inches produce the greater percentage of marketable heads. Sand proved an excellent medium with which to cover the forcing roots in that it blanched the leaves perfectly and promoted the formation of desirable

heads. Temperatures ranging between 50° and 60° F. were found satisfactory for the forcing soil. The crop harvested warranted the conclusion that Witloof chicory may be forced satisfactorily and profitably in America either in greenhouses or cellars.

PUBLICATIONS ISSUED DURING 1916.

BULLETINS.

No. 414. January. New or noteworthy fruits. IV. U. P. Hedrick. Pages 10, colored plates 5.
No popular edition issued.

No. 415. February. Plant lice injurious to apple orchards: I. Studies on control of newly-hatched aphides. P. J. Parrott, H. E. Hodgkiss and F. H. Lathrop. Pages 43, plates 8, figs. 6.
Popular edition, pages 11, plates 2.

No. 416. March. Seed tests made at the Station during 1915: I. Inspection of agricultural seeds. II. Voluntary examinations for correspondents. M. T. Munn. Pages 20.
No popular edition issued.

No. 417. March. Some notes on the breeding of raspberries. R. D. Anthony. Pages 14, plates 8.
Popular edition, pages 4.

No. 418. March. Culture and forcing of Witloof chicory. J. W. Wellington. Pages 10, plates 3.
Popular edition, pages 4, plates 3.

No. 419. March. The cabbage maggot: Its biology and control. W. J. Schoene. Pages 62, plates 8, figs. 3.
Popular edition, pages 8, plates 2.

No. 420. May. Inspection of feeding stuffs. Pages 149.
No popular edition issued.

No. 421. May. Lime-sulphur *vs.* bordeaux mixture as a spray for potatoes. IV. M. T. Munn. Pages 7, plate 1.
No popular edition issued.

No. 422. July. Observations on some degenerate strains of potatoes. F. C. Stewart. Pages 39, plates 12.
Popular edition, pages 8, plates 2.

No. 423. August. Miscellaneous notes on injurious insects. P. J. Parrott and H. E. Hodgkiss. Pages 29, plates 8, figs. 4.
Popular edition, pages 8, plates 2.

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No popular edition issued.

No. 425. October. Report of analyses of samples of commercial fertilizers collected by the Commissioner of Agriculture during 1916. Pages 59.
No popular edition issued.

No. 426. October. Cork, drouth spot and related diseases of the apple. A. J. Mix. Pages 58, plates 12.
No popular edition issued.

No. 427. December. New or noteworthy fruits. V. U. P. Hedrick. Pages 7, colored plates 5.
No popular edition issued.

No. 428. December. Director's report for 1916. W. H. Jordan. (Pages 28).
No popular edition issued.

TECHNICAL BULLETINS.

No. 48. January. Chemical changes in the souring of milk. Lucius L. Van Slyke and Alfred W. Bosworth. Pages 12.

No. 49. February. Counting bacteria by means of the microscope. Robert S. Breed and James D. Drew. Pages 31, plates 2, figs. 5.

No. 50. March. Tree crickets as carriers of *Leptosphaeria coniothyrium* (Fckl.) Sacc. and other fungi. W. O. Gloyer and B. B. Fulton. Pages 22, plates 4.

No. 51. March. Are spore-forming bacteria of any significance in soil under normal conditions? H. Joel Conn. Pages 9.

No. 52. March. A possible function of Actinomycetes in soil. H. Joel Conn. Pages 11.

No. 53. May. I. The number of colonies allowable on satisfactory agar plates. Robert S. Breed and W. D. Dotterer. Pages 11.
II. A comparison between agar and gelatin as media for the plate method of counting bacteria. H. J. Conn and W. D. Dotterer. Pages 4.

No. 54. May. Concerning the utilization of inosite in the animal organism. I. Concerning the effect of inosite upon the respiratory exchange in the dog. R. J. Anderson. Pages 9. II. The effect of inosite upon the metabolism of man. R. J. Anderson and A. W. Bosworth. Pages 7.

No. 55. August. Concerning certain aromatic constituents of urine: A study of the non-phenolic volatile oils isolated from the urine of cows, goats, horses and human beings. R. J. Anderson. Pages 25.

No. 56. December. The leaf weevil (*Polydrusus impressifrons* Gyll.) P. J. Parrott and H. Glasgow. Pages 24, pls. 8, figs. 6.

CIRCULARS.

(These circulars, except No. 47, were printed in limited editions only, for use in Station correspondence, not for general distribution)

No. 47. January 20. Plant-foods for crops in 1916. L. L. Van Slyke. Pages 8.

No. 48. February 15. Culture of cabbage. J. W. Wellington. Pages 5.

No. 49. April 15. The cherry leaf-beetle. F. Z. Hartzell and P. J. Parrott. Pages 3, plates 2.

No. 50. May 15. Periodical cicada in 1916. P. J. Parrott and H. E. Hodgkiss. Pages 3, plates 2.

No. 51. May 15. Some insects attacking the pear and their control. P. J. Parrott. Pages 18, figs. 19.

REPORT

OF THE

Department of Bacteriology.

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TABLE OF CONTENTS.

I. Counting bacteria by means of the microscope.

II. Are spore-forming bacteria of any significance in soil under normal conditions?

III. A possible function of Actinomycetes in soil.

IV. The number of colonies allowable on satisfactory agar plates.

V. A comparison between agar and gelatin as media for the plate method of counting bacteria.

REPORT OF THE DEPARTMENT OF BACTERIOLOGY.

COUNTING BACTERIA BY MEANS OF THE MICROSCOPE.*

ROBERT S. BREED AND JAMES D. BREW.

SUMMARY.

1. The present bulletin discusses the technique involved in counting bacteria in milk and other substances by means of a microscope, giving at the same time the results of studies which have been made in order to determine the sources and the amounts of the errors in counts made in this way.

2. The results obtained from the examination of samples of milk collected in clean test tubes containing preservatives indicate that just as accurate counts of the number of bacteria present can be made from such samples as can be made if the samples are collected in sterile tubes and iced. Under certain conditions this method of collecting samples may become a great convenience.

3. Capillary pipettes have been found to be more satisfactory for the measurement of 0.01 cubic centimeter quantities of milk than standardized wire loops.

4. Faulty calibration of pipettes has been found to be a serious cause of error. Allowance must be made for the adhesion of a certain quantity of milk to the pipette if accuracy of measurement is to be secured.

5. It has been found that sterilization of pipettes is an unnecessary refinement of technique and that a single pipette may be used for making preparations from a long series of samples, provided it is carefully cleaned in glass-cleaning solutions after each day's use and also cleaned by rinsing in fresh clean tap water after using in each sample and before passing to the next sample. Carelessness in cleaning pipettes causes marked errors in counts.

6. Growth of bacteria has been found to take place in the drops of milk as they dry so that it is important that these be prepared either from samples containing preservatives or that the milk be dried quickly. No growth was detected in the dried films even after incubation in a moist, 37° C. incubator for one to four days.

7. The claim made by some that bacteria are removed when the fat drops are dissolved by solvents does not seem to have any foundation in fact. The dried milk-solids-not-fat appear to act as a practically perfect fixative, no detectable mechanical loss of bacteria taking place when the fat drops are removed. On the

* A reprint of Technical Bulletin No. 49, February, 1916.

other hand, serious errors in count are introduced where the bacteria are stained in the milk before the dried films are prepared, because in this way the bacteria are not always sufficiently stained to make it possible to detect the full number present. Where the fat drops are left in the films, even though these be spread out so as to be in a very thin layer, they tend to obscure bacteria and so lower the count.

8. The two essential conditions for making a reasonably accurate count of small objects, like bacteria, under a microscope are that the objects themselves be prepared in such a way that they are distinctly visible and recognizable and at the same time evenly distributed over the field of the microscope. These conditions are sometimes best secured in dried films, in other cases in liquid preparations.

9. Microscopical methods of examining dried milk-films are of value for two purposes: a. They may be used for the rapid examination of milk in order to grade it according to its bacterial quality, both the number and the character of the bacteria present being taken into account. A microscopical examination permits a fairly accurate guess as to the probable plate count which will be secured from a given sample of milk. b. They are also useful as research methods, the microscopical method being the only known method which permits a count of the number of individual bacteria. Microscopical counts of the number of isolated individual bacteria and compact clumps present in milk give figures which compare well with those obtained where petri plate methods of counting are used.

INTRODUCTION.

About two years ago the Station published a bulletin[1] discussing the value of a previously described method for determining the number of bacteria in milk. Since this time further tests of this method have been made and it has been shown to have a real value. In these additional tests much has been learned in regard to the most convenient ways of using the technique for routine work, the common sources of error and the like. The new results are summarized here for the use of other laboratory workers.

HISTORICAL.

Methods for estimating the number of bacteria in given substances by means of the microscope have been in use since the earliest days of bacteriology. Similar methods have also been used and are being used for counting blood cells, fat drops, yeast cells, cells in milk, and other small objects. These methods have been extensively

[1] Brew, James D. A comparison of the microscopical method and the plate method of counting bacteria in milk. N. Y. Agr. Exp. Sta. Bul. 373, pp. 1–38, 1 pl., 2 figs. 1914.

developed since 1878[2] by the medical profession for use in counting blood cells.[3] They are the most accurate known methods of counting minute objects.

One of the chief difficulties which is met with in using the microscope in this way has been the preparation of the substance containing the bacteria, yeasts, blood cells, and the like, in such a way as to show the objects to be counted distinctly and at the same time evenly distributed over definite areas. These two things are essential if an accurate count is to be made, as the number of the objects to be counted necessitates a computation of the whole number after an examination of a small part of the whole preparation.

This difficulty of preparation, combined with the error involved in measuring the small quantities of the substances used has always prevented the making of absolutely accurate counts. Thus, even under the most favorable conditions the counts so secured must be regarded as " estimates " rather than as true " counts."

In the early days of bacteriology, it was a common practice to estimate the number of bacteria present in liquids by means of the microscope as a preliminary step to the making of pure cultures by the dilution method.[4] Thus it is not strange that Eberle,[5] working in Escherich's laboratory in 1896, was led to devise a method of preparing dried films from infants' feces in which a loopful of the material was spread over a measured area. The dried films were then stained and the number of bacteria determined by means of the microscope.

Two years later Winterberg,[6] working independently, was led to develop the technique which had previously been devised for counting blood cells, into a technique for counting the number of individual bacteria in liquid cultures. A man who deserves much credit for realizing the possibilities of microscopical methods of counting bacteria is Alex. Klein, who developed a technique somewhat different from either of those already mentioned. Klein published a preliminary description of this method in 1900.[7] In his method, the bacteria were first colored by the addition of the stain

[2] Abbe, E. Ueber Blutkörperzählung. *Sitzber. d. Gesellsch. f. Med. u. Naturw. Jena.* 1:173–180, 1878.

[3] Lyon, J. F., and Thoma, R. Ueber die Methode der Blutkörperzählung. Virchow's *Archiv. path. Anat. u. Physiol,* 84:131–163. 1881. See also any recent textbook discussing blood technique.

Thoma, R. Die Zählung der weissen Zellen des Blutes. Virchow's *Archiv. path. Anat. u. Physiol.* 87:201–209. 1882.

[4] Hueppe, Ferdinand. Die Methoden der Bakterien-Forschung. VIII + 495 pp., 5te Aufl., Wiesbaden. 1891.

Lafar, Franz. Technische Mykologie. 1:114–117. Jena. 1897.

[5] Eberle, Robert. Zählung der Bakterien im normalen Säuglingskot. *Centbl. Bakt.*, Abt. I, 19:2–5. 1896.

[6] Winterberg, Heinrich. Zur Methodik der Bakterienzählung. *Ztschr. Hyg.*, 29:75–93. 1898.

[7] Klein, Alex. Eine neue mikroskopische Zählungsmethode der Bakterien. *Centbl. Bakt.*, Abt. I, 27:834–835. 1900.

directly to the emulsion before examination, and then dried films were prepared on cover glasses in a manner similar to that used by Eberle. The measurement of the small quantities used was by means of platinum loops. Hehewerth,[8] while a student in Klein's laboratory, worked out the detailed application of this technique to pure cultures and feces, and showed its value in comparison with the plating methods devised by Koch. These microscopical methods of counting bacteria have been further used with or without modifications for the study of fecal bacteria and pure cultures by Klein,[9] DeLange,[10] Hellström,[11] MacNeal, Latzer and Kerr,[12] Viehoever,[13] and others. One of the most important of the later suggestions is one by Klein [14] of the addition of a loopful of gelatin to the bacterial suspension on the cover glass, the purpose of the latter being to act as a fixative. The suggestion of Klein was later modified by MacNeal, who added the gelatin directly to the emulsion before preparing the smear on the cover glass.

During the summer of 1903, Winslow [15] compared a microscopical method of counting bacteria in sewage which he devised with the plate method, reaching the conclusion that it had valuable possibilities. This was further tested by Winslow and Willcomb.[16] So far as known to the writers no one else has ever followed up this application of the microscopical method to the counting of sewage bacteria. The technique used was essentially the same as that used by Eberle and Klein.

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[8] Hehewerth, F. H. Die mikroskopische Zählungsmethode der Bakterien von Alex. Klein und einige Anwendungen derselben. *Arch. Hyg.*, 39:321–389. 1900. Also published as inaugural dissertation from the University of Amsterdam.

[9] Klein, Alex. Bacteriologic researches of human faeces. *Proc. Sect. Sci., Koninklijke Akad. van Wetenschappen te Amsterdam*, 4:65–76, 1901. 1902. Ibid. The physiological bacteriology of the intestinal canal. 4:477–489, 1902. Also published in Dutch.

Klein, Alex. Die physiologische Bakteriologie des Darmkanals. *Arch. Hyg.*, 45:117–176, 2 figs. 1902. Idem. Ueber die Bakterienmenge in menschlichen Fäces. *Ztschr. Klin. Med.*, 48:163–170. 1903. Idem. Bemerkung zu der Arbeit Dr. Max Lissauers " Ueber den Bakteriengehalt menschlicher und tierischer Fäces". *Arch. Hyg.*, 59:283–285. 1906.

[10] De Lange, Cornelia. Zur Darmvegetation gesunder Saüglinge. *Jahrb. Kinderheilk.*, 54:721–733. 1901.

[11] Hellström, F. E. Untersuchungen über Veränderungen in der Bakterienzahl der Fäces bei Neugeborenen. *Arch. Gynaek.*, 63:643–676. 1901.

[12] MacNeal, W., Latzer, L. L., and Kerr, J. E. The fecal bacteria of healthy men. *Jour. Inf. Dis.*, 6:123–169, 571–609. 1909.

[13] Viehoever, Arno. Botanische Untersuchung harnstoffspaltender Bakterien mit besonderer Berücksichtigung der speziesdiagnostisch verwertbaren Merkmale und des Vermögens der Harnstoffspaltung. *Centbl. Bakt.*, Abt. II, 39:209–359. 1913.

[14] See first reference given in footnote 9.

[15] Winslow, C.-E. A. The number of bacteria in sewage and sewage effluents determined by plating upon different media and by a new method of direct microscopical enumeration. *Jour. Inf. Dis.*, Suppl. 1:209–228. 1905.

[16] Winslow, C.-E. A. and Willcomb. Tests of a method for the direct microscopical enumeration of bacteria. *Jour. Inf. Dis.*, Suppl. 1:273–283. 1905.

During the same decade (1900–1910), because of the interest which had developed in the question of the significance of the body cells in milk, microscopical methods of counting these were devised. In using the form of this technique which was finally developed for routine work,[17] Slack was led to notice a relation between the number of bacteria which appeared in the slime obtained by centrifuging samples of milk and plate counts from the same samples.[18] By observation on a large number of samples he worked out an arbitrary relation between the two. This ratio was used as a means of selecting samples of milk with high bacterial counts. The selected samples were plated by the usual technique to determine the bacterial counts. Later, Goodrich [19] compared the same techniques.

While working in the Boston Bio-Chemical Laboratory during the summer of 1909, the senior author of this bulletin made a series of tests of the Stewart-Slack method referred to above with the purpose of using it in studying the number of body cells in milk. As a result of the study, it became evident that a large number of cells were lost during the process of centrifugation. At this time the technique discussed in the present bulletin was devised. By its use the number of body cells present in whole milk was determined directly without the use of the centrifuge. Because of many courtesies shown and suggestions made by Prof. Prescott, Director of the Laboratory, it was decided to publish the account of the work under joint authorship. A preliminary account of the work was given at the Richmond meeting of the American Public Health Association, in October, 1909,[20] and the complete account published later.[21]

Among the preparations made for counting the tissue cells were many that showed bacteria so clearly that it at once became apparent that this technique was satisfactory for counting bacteria as well as cells. On looking the matter up, it was discovered that while the principle involved was not new, the technique itself was new as applied to milk. Because of the lack of opportunity for extended research at the time a brief note was published by the senior author of the present bulletin [22] giving its application and a few preliminary comparative counts.

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[17] Committee on Standard Methods of Bacterial Milk Analysis. Report. *Amer. Jour. Pub. Hyg.*, 20 (N. S. 6):315–345. 1910.

[18] Slack, Francis H. The microscopic estimate of bacteria in milk. *Technology Quart.*, 19:1–4. 1906. Idem. Die mikroskopische Schätzung der Bakterien in der Milch. *Centbl. Bakt.*, Abt. II, 16:537–538. 1906.

[19] Goodrich, G. W. Comparison of the plating and the microscopical methods in the bacteriological examination of milk. *Jour. Inf. Dis.*, 14:512–519. 1914.

[20] Prescott, S. C., and Breed, R. S. The determination of the number of body cells in milk by a direct method. *Amer. Jour. Pub. Hyg.*, 20 (N. S. 6):663–664. 1910.

[21] Prescott, S. C., and Breed, R. S. The determination of the number of body cells in milk by a direct method. *Jour. Inf. Dis.*, 7:632–640. 1911.

[22] Breed, R. S. The determination of the number of bacteria in milk by direct microscopical examination. *Centbl. Bakt.*, Abt. II, 30:337–340. 1911.

In 1912, the junior author of this bulletin was called upon to make test of this technique as a means of judging milk quality under the direction of Dr. H. A. Harding. Before this work was completed, Dr. Harding was called away from the Geneva Station and it fell to the lot of the senior author to supervise the publication of the results secured. These were published [23] with the purpose of showing others the possibilities of the method, hoping thereby to secure a general trial of the method which would demonstrate its value or lack of value. So well has this purpose succeeded that a number of extensive tests are being or are soon to be made. Some results of these tests have already been published.[24]

Several years after the original publication of the method discussed in this Bulletin, Skar,[25] working independently, published an account of a similar method of counting bacteria in milk. The chief difference between his technique and that used in our work is that the bacteria are stained in the milk before the smear is prepared and the fat drops are not removed. Thereby all washing of the smear is avoided. A discussion of the advantages and disadvantages of this form of technique is given later (see pages 22–24). Since then [26] accounts of two investigations have been published in which this method was used.

A year later Rosam [27] also described a method for counting bacteria in milk by means of the microscope. This method consisted of the examination of a drop of milk placed on a glass slide under a cover glass of known area. This technique uses the same principles as those used in Winterberg's technique but in much simpler and cruder form.

During the past four years two attempts have been made to use similar methods of counting bacteria in water. The first of these two methods was devised by Müller.[28] In order to count the bacteria, those contained in 100 cubic centimeters of water are precipitated in the flocculent precipitate produced by adding liquor ferri-oxychlorati. Formalin is added in order to prevent further multiplication of the bacteria. After decanting, the sediment is stained with gentian violet,

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[23] See footnote 1.

[24] Conn, H. W. Standards for determining the purity of milk. U. S. Pub. Health Serv., *Pub. Health Reports*, 30:2349–2395. 1915.

[25] Skar, Olav. Eine schnelle und genaue Methode für Zählung von Bakterien und Leukocyten. *Milchw. Zentb.*, 41:454–461, 705–712. 1912.

[26] Skar, Olav. Verhalten der Leukocyten der Milch bei der Methylenblau-Reductaseprobe. *Ztschr. Fleisch- u. Milchhyg.*, 23:442–447. 1913. Jacobsen, Adolf. Die Milchkontrolle in der Stadt Kristiania. *Ztschr. Fleisch- u. Milchhyg.*, 24:512–517, 529–532. 1914.

[27] Rosam, A. Eine einfache mikroskopische Beurtheilung des Gehalts der Milch in Mikroorganismen. *Milchw. Zentbl.*, 42:333–334. 1913.

[28] Müller, Paul Th. Uber eine neue, rascharbeitende Methode der bakteriologischen Wasseruntersuchung und ihre Anwendung auf die Prüfung von Brunnen und Filterwerken. *Arch. Hyg.*, 75:189–223. 1912. Ibid. Über meine Schnellmethode der bacteriologischen Wasseruntersuchung. *Arch. Hyg.*, 82:57–75. 1914.

centrifuged to reduce the volume to one cubic centimeter; two hundredths of a cubic centimeter of this precipitate is then spread on one square centimeter, dried and examined for bacteria. Considerable use of this technique has been made by Müller and it has also been tested by Hesse.[29] Donald,[30] on the other hand, has used a measured drop of water (obtained by the use of a special dropping pipette) which is dried on a glass slide, fixed to the slide, stained in carbofuchsin, and decolorized in alcohol. In certain cases he toughened the film which contained the bacteria by adding gelatin, albumen or collodion to the drop of water before drying.

METHOD APPLIED TO MILK.

GENERAL DESCRIPTION OF THE TECHNIQUE USED IN COUNTING BACTERIA IN MILK BY THE DIRECT MICROSCOPICAL METHOD.

In brief, the technique used in making counts of the number of bacteria in milk by the direct microscopical method is as follows: One hundredth of a cubic centimeter of milk or cream is measured by means of a *clean* capillary pipette accurately calibrated to discharge this quantity of milk. The milk or cream is deposited on a *clean* glass slide. By means of a stiff needle the drop of liquid is spread evenly over an area of one square centimeter and *dried quickly* in a warm place protected from dust, flies and cockroaches. The surface on which the slides rest must be level in order that the films may dry evenly.

The dry smears are then prepared for microscopical examination by immersing the slide in xylol or other fat solvent for one minute or longer if desired. After this the slide is drained and dried, immersed in 70 to 90 per ct. grain or denatured alcohol for one or more minutes, then transferred to a fresh, saturated, aqueous solution of methylene blue. Old or unfiltered solutions are to be avoided as they may contain troublesome precipitates. The slides remain in this solution for five seconds to one minute or longer depending on the effect desired. They are then rinsed in water to remove the surplus stain and decolorized in alcohol. This takes several seconds to minutes during which time the slide should be under observation in order that it may be removed from the alcohol before decolorization has proceeded too far. When the decolorization is completed the general background of the film should have a pale blue tint. Where staining has been prolonged a deep blue margin or deep blue central patches may persist. These deeply stained

[29] Hesse, Erich. Über Paul Th. Müllers Schnellmethode der bakteriologischen Wasseruntersuchung. *Arch. Hyg.*, 83:327–349. 1914.

[30] Donald, R. An apparatus for liquid measurement by drops and applications in counting bacteria and other cells and in serology, etc. *Proc. Roy. Soc., London*, Ser. B, 86:198–202. 1913. Idem. A method of counting bacteria in water. *Lancet*, 184:1447–1449. 1913.

areas do not contain more bacteria than other parts of the film and may be removed, if troublesome, by decolorizing and restaining lightly.

After drying, the slides are ready for microscopical examination or they may be filed away and preserved indefinitely. Poorly stained slides may be decolorized and restained as many times as necessary without any apparent injury. If desired, the films may be mounted in Canada balsam with cover glasses, but in routine work it is customary to apply cedar oil directly to the film for examination under an oil-immersion lens.

DETAILED DISCUSSION OF THE VARIOUS PROCESSES INVOLVED AND OF POSSIBLE ERRORS.

Collection of samples.— Some comparative counts have been made (Bd.) in order to discover whether samples of milk taken in clean test tubes containing preservatives (formalin and corrosive sublimate) were as satisfactory for use in making microscopical counts as iced samples taken in sterile tubes. The results secured are not sufficient to warrant a positive statement but indicate that samples taken with preservatives are fully as satisfactory as are iced samples and are more convenient to handle. When an effort was made to keep the preservative samples for days or weeks, it was discovered that there was a tendency for them to become less satisfactory on standing. This was not because the organisms lost their staining power or because of any growth of the organisms but because many bacteria floated to the top with the cream while others fell to the bottom. Because of the fact that it was impossible to break up the compact cream which formed after the sample had stood for some time and also because some sediment remained even after thorough shaking of the tubes, the counts made at the end of days or weeks tended to be lower than they should have been.

Counts made from the cream and the sediment of both iced and preservative samples showed that this concentration of the bacteria in the cream and sediment occurred in all of the samples. Where no cream was present, as in skim milk, the bacteria did not rise to the surface but sedimented in large numbers showing that the reason for their concentration in the cream was because they were buoyed up on the fat drops as they rose to the surface. In the samples studied there was a very noticeable tendency for all of the larger clumps of bacteria to float with the cream, the bacterial groups in the sediment rarely consisting of more than two individuals. The most apparent explanation for this fact is that the large clumps were more easily caught as the fat drops floated to the surface while some single individuals or small groups fell through between the

fat drops to the bottom. This entire action is similar to that already noted by one of us in a previous paper as occurring to the body cells in milk.[31]

If this method of collecting samples with preservatives proves as successful as these results would indicate, it will make it possible to send samples of milk for microscopical examination for long distances and therefore allow the concentration of milk control work in central laboratories in a way that would eliminate the expense and trouble due to shipping iced samples.

TABLE I.— WEIGHT OF MILK DISCHARGED FROM A STANDARDIZED WIRE LOOP AND FROM A STANDARDIZED 0.01 C. C. PIPETTE.

Wire loop.	Pipette.
Gram.	*Gram.*
.0100	.0102
.0083	.0102
.0133	.0103
.0136	.0101
.0110	.0101
.0114	.0101
.0088	.0102
.0090	.0102
.0114	.0101
.0072	.0102
.0095	.0101
.0145	.0102
.0131	.0101
.0120	.0100
.0110	.0101
.0148	.0101
.0115	.0101
.0118	.0101
.0110	.0102
.0090	.0102
Average....... .0111	.0101
Maximum variation from mean 35 per ct.	2 per ct.

Measurement of sample.— There are two common ways of measuring the small quantities of milk required in the microscopical method of counting bacteria. One is by means of platinum loops and the other by means of capillary pipettes. Of these the loop method is the more convenient and has been frequently used for this purpose (Eberle, Klein, Hehewerth, De Lange, Hellström, MacNeal, Latzer

[31] Breed, R. S. Die Wirkung der Zentrifuge und des Separators auf die Verteilung der Zellelemente in der Milch, nebst einer Kritik der zur Bestimmung der Zellenzahl in der Milch verwendeten neuen Methoden. *Arch. Hyg.*, 75:383–392. 1911.

and Kerr, Rosam). Others have used pipettes (Winslow, Winslow and Willcomb, Skar) or even a standardized drop method (Donald). H. W. Conn in his report on the cooperative tests conducted in New York City concludes [32] that the wire loop as used by one of the laboratories in measuring milk for making counts appears to yield results as accurate as those secured by the use of pipettes. This conclusion is based on comparative counts, but is contrary to what one of us had previously found and reported.[33]

In order to test the matter, further series of weighings were undertaken (Bw.). This is a more accurate way of determining the relative accuracy of the two methods than comparative counts since the comparison is much more direct. Table I shows the results of twenty trials each with pipettes and with loops. In these cases care was taken to secure as accurate results as possible by both methods. The results show a maximum variation from the mean of 2 per ct. for the pipette while the loop showed a maximum variation of 35 per ct. The loop in each case was pulled out of the liquid vertically and was handled as carefully as possible. In spite of this the amount of variation in the quantity of milk was so great as to be readily detected by the eye.

Ten weights were then made of milk discharged from the pipettes quickly in the same manner as used in the routine work but the results showed no more variation than those given in Table I. Deliberate carelessness in allowing milk to run back on the tips of the pipettes and the like failed to produce as great an error as 35 per ct. Moreover these conditions were at once evident. Our experience therefore leads us to believe that only a careless person would introduce large errors in measuring the quantity of milk required if pipettes are used and that loops large enough to carry 0.01 cubic centimeter are unsatisfactory.

Form of pipette.— At present nearly all of the reputable supply houses are making special capillary pipettes for use in connection with the microscopical examination of milk. The cheapest and most convenient forms are straight capillary-tube pipettes, discharging 0.01 cubic centimeter and long enough to reach the bottom of a test tube easily (Fig. 1). The bore of the pipette should be of such a size that the distance from the graduation mark to the tip is between 1½ and 2½ inches. A convenient form of pipette is also shown in Fig. 2. This has a reservoir just above the graduation mark which influences the filling of the pipette by capillarity in such a way that it fills to a point just above the mark.

The milk in either type of pipette is easily controlled by first wiping the exterior of the pipette with a *clean* towel and then touching the tip of the pipette gently with the *clean* towel until the milk

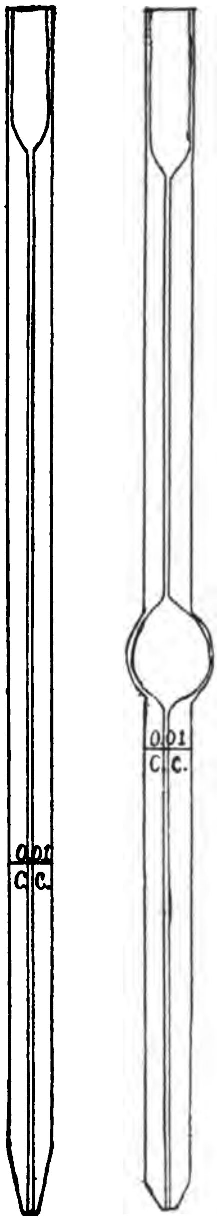
[32] See p. 2391 in reference given in footnote 24.
[33] See p. 34 in reference given in footnote 1.

in the pipette is lowered to the mark. The tip of the pipette now being *clean*, the milk is blown out of the pipette very carefully so that all the milk possible is delivered.

Calibration of pipettes.— The proper calibration of the pipettes has proved to be troublesome because of the fact that in discharging so small a quantity of milk as 0.01 cubic centimeter, the error due to adhesion of the milk to the inner walls and tip of the pipette becomes important. For this reason a large number of trials have been made to determine the amount of this error. Having determined, by repeated trials, the correct calibration of a pipette made to deliver 0.01 cubic centimeter of milk, specific gravity 1.032 at 21° C., it was found by experiment that such a pipette would contain .0104+ grams of distilled water at 21° C. or .1423 grams of mercury having a specific gravity of 13.552 at 21° C. In other words if these pipettes are calibrated with mercury, they should be so calibrated as to contain between .0104 and .0105 cubic centimeter of mercury in order to allow for the loss of milk due to adhesion to the glass.

A convenient method of calibration with milk is to weigh the milk as discharged into the hollow of a clean, hollow-ground slide, covering the hollow with a clean cover glass to prevent evaporation, then from the specific gravity calculate the error and correct the graduation mark accordingly. All capillary pipettes should be recalibrated, as experience has shown that it is impossible to rely upon the accuracy of the best of the pipettes as supplied by dealers. Errors as large as 50 per ct. have been found in pipettes the accuracy of which was guaranteed. In all of our work we have taken the average specific gravity of milk to be 1.03 at 21° C. so that the weight of 0.01 cubic centimeter becomes 0.0103 grams.

Tip of the pipette.— Experience has shown that milk is most easily discharged cleanly from a tip having the form of a truncated cone with the flat end, a circle of about 2 millimeters in diameter. The angle of slope of the cone appears to make little difference. See Figs. 1 and 2.



1 2

FIGS. 1 AND 2.— CONVENIENT FORMS OF CAPILLARY PIPETTES.

Cleaning and sterilization of pipettes.— In the original description of the microscopical technique, it was stated that it was necessary to use

clean pipettes but that sterilization was unnecessary. This statement was made because of the fact that the rapid drying of the smear prevents the growth of the few accidental bacteria which get into the milk from clean glassware, while sterilization would not help the matter unless the bodies of the bacteria present were actually destroyed by the heat. The best way which has been found to clean the pipettes is to immerse them in an ordinary glass-cleaning solution containing sulphuric acid and potassium bichromate. They are afterward rinsed in clean water. If desired to dry them this may be accomplished quickly by using alcohol or ether.

Tests were therefore made by one of us (Bw.) to determine whether there is sufficient contamination from the clean pipettes to cause noticeable errors in the counts and to determine whether pipettes could be cleaned rapidly enough to permit the use of a single pipette for routine work. The results of these tests are given in Table II.

TABLE II.— COMPARATIVE COUNTS OF BACTERIA ON MILK SMEARS MADE BY USING STERILE, CLEAN AND DIRTY PIPETTES.

Series 1	Series 2	Series 3	Series 4
PLATE COUNTS PER CUBIC CENTIMETER MADE AT THE BEGINNING.			
A^{1}..........1,250	B^{1}...........55	C^{1}..........110	D^{1}............20
M^{2}........curdled	N^{2}....5,700,000	O^{2}....37,500,000	P^{2}....418,000,000
A^{3}..........5,000	B^{3}...........55	C^{3}...........85	D^{3}............30
A^{4}..........6,000	B^{4}..........110	C^{4}...........95	D^{4}............60
A^{5}..........3,000	B^{5}..........125	C^{5}..........125	D^{5}............45
A^{6}..........4,300	B^{6}..........170	C^{6}..........150	D^{6}............55
MICROSCOPIC COUNTS SHOWING TOTAL INDIVIDUAL BACTERIA PER CUBIC CENTIMETER.			
I. An individual, clean, sterile pipette used for each sample.			
A^{1}.........22,500	B^{1}........3,000	C^{1}........6,000	D^{1}.........9,000
M^{2}........curdled	N^{2}...15,750,000	O^{2}..160,200,000	P^{2}....914,000,000
A^{3}.........25,500	B^{3}.......15,000	C^{3}.......12,000	D^{3}.........4,500
A^{4}..........4,500	B^{4}.......12,000	C^{4}.......10,500	D^{4}.........3,000
A^{5}..........6,000	B^{5}........1,500	C^{5}........9,000	D^{5} less than 3,000
A^{6}..........4,500	B^{6}........6,000	C^{6}........1,500	D^{6}.........3,000
II. Same as I, except the pipettes were not sterilized.			
....	....	C^{1}........1,500	D^{1}.........3,000
....	....	O^{2}...160,200,000	P^{2}....914,000,000
....	....	C^{3}........4,500	D^{3}.........9,000
....	....	C^{4}........3,000	D^{4}.........3,000
....	....	C^{5}........6,000	D^{5} less than 3,000
....	....	C^{6}........3,000	D^{6}.........6,000

TABLE II (*continued*).

Series 1	Series 2	Series 3	Series 4
III. One clean pipette used for all. After each smear the pipette was recontaminated in the high count sample and rinsed in clean water.			
		C^1........3,000	D^1.........4,500
		O^2...160,200,000	P^2... 914,000,000
		C^3........4,500	D^3.........6,000
		C^4........6,000	D^4.........7,500
		C^5........7,500	D^5.........1,500
		C^6............	D^6.........4,500
IV. Same as III, except that the pipette was rinsed in the sample to be smeared but not in water.			
A^1..........1,500	B^1........6,000	C^1............	D^1.........4,500
M^2........curdled	N^2...15,750,000	O^2...160,200,000	P^2...914,000,000
A^3.........58,500	B^3.......51,000	C^3......400,000	D^3........85,000
A^4.........63,000	B^4......129,000	C^4......385,000	D^4.......110,000
A^5........294,000	B^5......132,000	C^5............	D^5.......795,000
A^6.........39,000	B^6......132,000	C^6......180,000	D^6.......435,000
V. Same as IV but not rinsed. Grossest carelessness possible.			
A^1..........3,000	B^1........9,000		
M^2........curdled	N^2...15,750,000		
A^3....52,510,000	B^3....2,720,000		
A^4....75,600,000	B^4....3,000,000		
A^5......1,260,000	B^5....1,230,000		
A^6......3,930,000	B^6....1,530,000		
PLATE COUNTS PER CUBIC CENTIMETER MADE AT THE END.			
		C^1..........115	D^1...........200
		O^2....65,700,000	P^2...418,000,000
		C^3.........1,180	D^3.........4,530
		C^4.........1,575	D^4........73,000
		C^5..........995	D^5........10,400
		C^6.........2,050	D^6.........7,500

NOTE.— Counts are designated by letters bearing exponents. All counts bearing the same letter but different exponents were made from duplicate samples taken from the same pail of milk. Counts bearing the same exponent as well as the same letter were made from the same sample of milk.

Five flasks of a low-count milk were used in each of the four series of experiments recorded in this table. These are indicated by the letters A, B, C and D bearing exponents 1, 3, 4, 5, and 6. One flask of high-count milk which had been secured by inoculating with a culture of the colon bacillus was used in each of the four series.

This is indicated by the letters M, N, O, and P all bearing the exponent 2. Samples A,^{1} B,^{1} C,^{1} and D^1 were used as check samples. Samples M,^{2} N,^{2} O,^{2} and P^2 were used for the purpose of contaminating the pipettes. Plate counts made from the samples before they were used in the experiments are given at the top of the table and plate counts made at the end are given at the bottom of the table. These were made on lactose agar, the plates being incubated for 5 days at 21° C. followed by two days incubation at 37° C.

In each of the four series of tests, smears were first prepared from all of the samples by using an individual, *clean, sterile pipette* for each sample. The results secured are recorded under I in the table. The variations in the counts which are noted as occurring in samples bearing the same letter show the normal range of variation in count which may be expected where the microscopical method of counting is used. In Series 3 and 4, after preparations had been made by the use of the sterile pipettes, smears were also prepared by the use of individual *clean*, but *unsterilized pipettes*. The results of the counts secured are recorded under II. It will be seen that the counts show no increase over and no greater variation than those recorded under I.

After these preparations had been made with the individual pipettes, another set of preparations was made from the samples used in Series 3 and 4. In each of these two series a *single pipette* was used in making the set of six preparations. After the first smear had been made with the clean pipette from the check sample (C^1 or D^1), the pipette was thereafter *cleaned by rinsing in clean tap water* in passing from sample to sample. In order to make the test as severe as possible, the pipette was contaminated just before cleaning by drawing some of the high-count milk into it (O^2 or P^2). The results of the counts are given in the table under III. An examination of the counts will show that they are of the same magnitude as those made where individual pipettes were used in making each preparation. Moreover, not a single organism was seen in any of the low-count smears which was of the type of the easily recognizable organism in the milk used in contaminating the pipettes. The latter test is a very severe test of the efficiency of the cleaning method used because it would reveal even slight contaminations.

In order to determine the effect on the count of greater carelessness in the use of the pipettes, another set of preparations was made from each of the four sets of samples. A *single pipette* was used for each set of samples and was *not cleaned in passing from sample to sample.* After the preparation from the check sample had been made, the pipette was contaminated in each case in the high-count sample and was then used immediately to make the smear from the next sample. *As the milk was being drawn into the pipette from the sample, it was rinsed several times in the sample itself.* The results of these tests are recorded in the Table under IV. All of the smears made with

PLATE I.— DRAWINGS OF MILK SMEARS AS SEEN UNDER THE MICROSCOPE.

All prepared in such a way that each bacterium or tissue cell seen is equivalent to 400,000 per cubic centimeter.

GOOD QUALITY MILK.

FIG. 1.— No bacteria seen. Two tissue cells. Cell count = 800,000 per c. c.

MILK SOURING NORMALLY.

FIG. 3.— Milk which is nearly sour. The majority of the bacteria are lactic acid bacteria. One tissue cell. Bacterial count = 80,000,000 per c. c. Cell count = 400,000 per c. c.

PLATE I — DRAWINGS OF MILK SMEARS AS SEEN UNDER THE MICROSCOPE.

All prepared in such a way that each bacterium or tissue cell seen is equivalent to 400,000 per cubic centimeter.

MILK OF FAIR QUALITY.

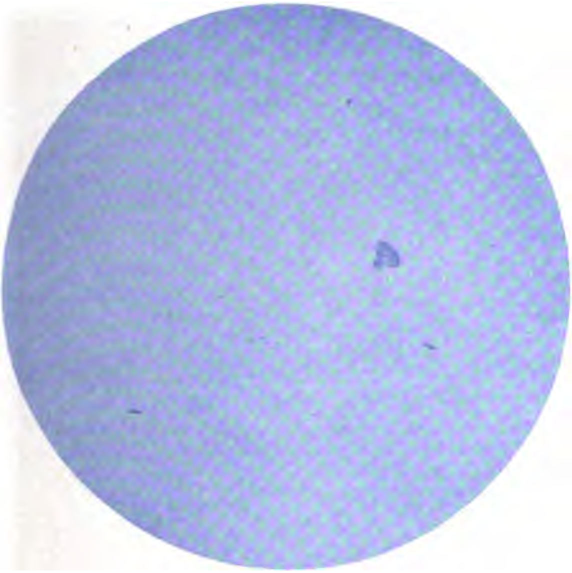


FIG. 2.— Two pairs of lactic acid bacteria and one single bacterium. One tissue cell. Bacterial count = 2,000,000 per c. c. Cell count = 400,000 per c. c.

POOR QUALITY MILK.

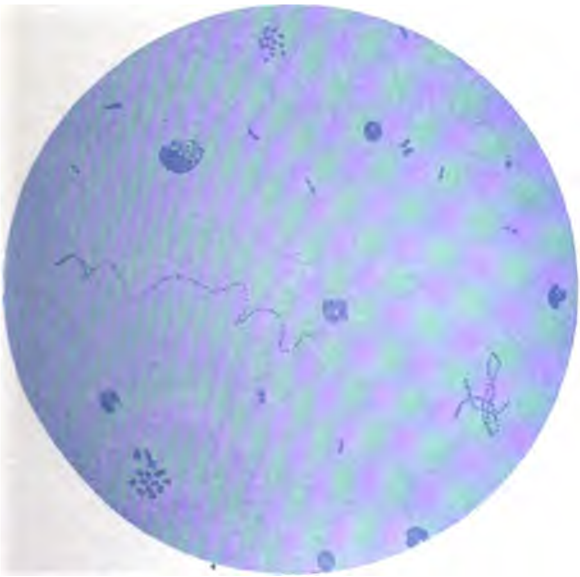


FIG. 4.— Milk which is both nearly sour and suspicious in sanitary quality. Seven tissue cells. Bacterial count = 100,000,000 per c. c. Cell count = 2,800,000 per c. c.

the pipettes used in this way showed the presence of organisms from the high-count samples and the counts were markedly increased by their presence.

In the first two series of tests, sets of preparations were made from the samples in a still more (intentionally) careless manner, in that the *single pipette* used in making each set of preparations *was not rinsed after contamination, even in the sample* from which the smear was to be made. The results are recorded in the Table under V. As shown, both from the preparations themselves and from the counts, large numbers of bacteria were thus transferred from the high-count samples to the low-count samples, the counts being raised from less than ten thousand per cubic centimeter to millions per cubic centimeter by this procedure.

The results given in this table indicate (1); that sterilization is not necessary (2) that individual pipettes for each sample are not necessary, and (3) that it is entirely permissible to use a single pipette in making a series of preparations provided it is properly cleaned by rinsing in clean tap water before each preparation is made. (4) They also show that cleanliness of pipettes is essential.

This conclusion is borne out by our experience in making extended series of analyses by the microscopical method. In one set of 2,475 comparative counts made between the microscope and plate methods in which the samples examined were random market milk samples, all of the microscopic preparations were made as indicated under IV. That is, a single pipette was used for each set of 30 to 50 samples without its being cleaned even in tap water. In this work it frequently happened that where a sample of a high-count milk appeared, followed by a sample of a low-count milk, there was evidence of contamination; but since this was a comparatively uncommon condition, the ratings given by the microscope were affected in only a comparatively small number of cases by the contamination thus introduced.

However, since there was clear evidence that these contaminations did affect the rating of some samples this method of using the pipettes was given up. The method of cleaning by rinsing with clean tap water has been tried in a series of 5,600 examinations of market milk samples. Not the slightest evidence of contamination of samples has been detected in this series of tests although at least 10 per ct. of the samples would have given plate counts in the millions.

Drying the smear.—In describing this technique, the authors of this bulletin have always specifically stated that the smears should be dried quickly in a warm place and on a level surface. Too high a temperature will cause the films of dried milk to crack or peel from the glass. This drying can usually be accomplished within five minutes from the time the milk is deposited on the glass slide. It has always been felt that rapid drying was essential since the

possibility that the bacteria would grow in the smear during the drying process was always present. No tests to discover the importance of this possible source of error have been made until recently when one of us (Bd.) made the tests which are summarized in Table III.

TABLE III.—EFFECT OF SLOW DRYING ON THE NUMBER OF BACTERIA IN MILK SMEARS.

	Films dried in five min. in a warm place. Stained as soon as dry.	Films dried in ten min. in 37° C. incubator. Stained after four days incubation at 37° C.	Films dried slowly in one to one and one-half hrs. at room temperature. Stained as soon as dry.
A. Market milk kept at room temperature for some hours previous to examination; occasional large clumps of micrococci present.			
Number of individual bacteria per c. c....	122,700,000	99,840,000	247,080,000
Number of groups of one or more bacteria per c. c....	35,100,000	28,980,000	46,960,000
Average number of individual bacteria in each group....	3.5	3.5	5.3
Number of groups containing 30 or more individuals....	4	3	8
Total number of groups examined....	585	483	766
B. Market milk similar to A.			
Number of individual bacteria per c. c....	49,560,000	40,740,000	106,860,000
Number of groups of one or more bacteria per c. c....	11,040,000	10,380,000	10,740,000
Average number of individual bacteria in each group....	4.5	4.3	9.9
Number of groups containing 30 or more individuals....	3	3	12
Total number of groups examined....	184	173	177
C. Market milk similar to A.			
Number of individual bacteria per c. c....	40,260,000	48,360,000	103,560,000
Number of groups of one or more bacteria per c. c....	10,950,000	13,200,000	18,200,000
Average number of individual bacteria in each group....	3.6	3.9	5.7
Number of groups containing 30 or more individuals....	4	5	10
Total number of groups examined....	365	330	455

TABLE III (*continued*).

	Films dried in five min. in a warm place. Stained as soon as dry.	Films dried in ten min. in 37° C. incubator. Stained after four days incubation at 37° C.	Films dried slowly in one to one and one-half hrs. at room temperature. Stained as soon as dry.
D. Market milk, twenty hours after being drawn. Sample had stood on ice for four hours before being examined. Clumps of bacteria of irregular sizes present.			
Number of individual bacteria per c. c.	*523,000	430,000	716,000
Number of groups of one or more bacteria per c. c.	70,000	78,000	89,000
Average number of individual bacteria in each group	7.4	5.5	8.2
Number of groups containing 30 or more individuals	2	1	2
Total number of groups examined	94	52	72
E. Market milk similar to D in history but containing very few clumps of bacteria.			
Number of individual bacteria per c. c.	†22,000	36,000	22,500
Number of groups of one or more bacteria per c. c.	6,000	12,000	7,500
Average number of individual bacteria in each group	3.5	3.0	3.0
Number of groups containing 30 or more individuals	1	0	0
Total number of groups examined	8	8	5
F. Separated skim milk containing a predominant colon-like organism.			
Number of individual bacteria per c. c.	7,825,000	....	11,040,000
Number of groups of one or more bacteria per c. c.	5,225,000	....	6,565,000
Average number of individual bacteria in each group	1.5	....	1.7
Number of groups containing 30 or more individuals	0	....	0
Total number of groups examined	364	....	449

* One group containing about 600 individual bacteria was disregarded in computing this average. If it had been included this count would have become 961,000 per c. c. and the average size of group 14.

† One group of 78 was disregarded in computing this average. If it had been included this count would have become 79,000 per c. c. and the average size of group 13.

TABLE III (*continued*).

	Films dried in five min. in a warm place. Stained as soon as dry.	Films dried in ten min. in 37° C. incubator. Stained after four days incubation at 37° C.	Films dried slowly in one to one and one-half hrs. at room temperature. Stained as soon as dry.
G. Market milk inoculated with a culture of a bacterium which had a tendency to grow singly in milk.			
Number of individual bacteria per c. c....	12,665,000	15,420,000	14,535,000
Number of groups of one or more bacteria per c. c....	11,820,000	14,410,000	11,985,000
Average number of individual bacteria in each group....	1.1	1.1	1.2
Number of groups containing 30 or more individuals....	0	0	0
Total number of groups examined....	2,364	1,441	799

The purpose of these tests was twofold. One was to find out whether bacteria would grow in the dried films of milk if allowed to stand for some time before staining them and the other was to discover whether the bacteria grew rapidly enough in slowly drying drops of milk to produce a noticeable increase in the count. Three sets of preparations were therefore made from each of the seven samples of milk which were examined. The first slides were prepared in the usual way (see column one in table) drying being accomplished in about five minutes on a level surface over which an incandescent light was suspended. Staining of the slides was carried out as soon as they were dry. The preparations of the second set (see column two in table) were not dried as rapidly, as it was feared that the heat used might kill some of the bacteria. They were therefore dried in a 37° C. incubator in which place they dried in about ten minutes. After being dried they were left in the moist atmosphere of the incubator from one to four days (Samples A, B and C one day, Sample G two days, Samples D and E four days) and then stained. The preparations of the third set (see column three in Table III) were dried at room temperature, the process taking from one to one and a half hours. As soon as possible after the preparations were dried they were stained.

The preparations were then examined in order to determine the following points: (a) the number of individual bacteria per cubic centimeter, (b) the number of groups of one or more bacteria present, and (c) the average number of individuals in each group. At the

same time the number of large-sized groups of bacteria was noted, all groups containing more than 30 individuals being recorded. The total number of groups examined was also recorded, this being naturally very much greater in the milks containing numerous bacteria than in milks containing few bacteria.

A study of the results secured shows that the total number of bacteria present in the films dried and incubated in the 37° C. incubator was probably no greater than in the films dried and stained quickly, such differences in counts as are shown being within the range of experimental error. This observation is much strengthened by the fact that the average number of individual bacteria in the groups of bacteria was not increased. The force of this observation is realized when it is remembered that if growth had occurred in the dried films of milk, the result would have been to form minute colonies similar to those produced on agar plates or still more like those secured by Frost [34] in his microscopical preparations. Dried films of milk have been kept in this way for months without any evidence of growth.

When comparisons are made between the counts made on the films dried and stained quickly in the usual way and similar counts made on the films dried slowly at room temperature, the results show very differently. The total number of bacteria present increased in all but one instance. It is important to note that the greatest increases took place in those cases where it was known that the bacteria were in vigorous growing condition at the time the preparations were made. (Samples A, B and C.) In these cases the number of bacteria more than doubled in the time required for drying the milk. In the case of two samples (D and E) which had been kept on ice for four hours previous to the time the tests were made, it is probable that the increase noted in one case (D) signified some slow growth while none is indicated by the results secured from E. The results in the latter case, however, are less significant than those from other samples because of the fact that this sample contained so few bacteria that it was impossible to examine more than 5 to 8 groups in each preparation in place of the hundreds of groups examined in the other milks.

Sample F was an old skim milk which had been kept for several days in the cooler. Some growth is indicated by the results secured. Sample E was secured from a pail of high-grade fresh milk into which had been poured the contents of a test tube of skim milk containing an old culture of a bacterium. This was done in order to secure a sample containing many organisms of such a nature that they did not tend to form clumps, thus making it possible to secure more accurate counts than where the milk is filled with clumps of bac-

[34] Frost, W. D. Rapid method of counting bacteria in milk. *Sci.*, N. S. 42:255–256. 1915.

teria of irregular sizes. Some growth is indicated by the counts secured but the fact that it is not great suggests that the predominant organism was not in a vigorous condition.

Still more significant than the increase in the number of individual bacteria is the fact that the average number of individual bacteria in the groups increased in all cases where groups enough were examined to show what the real conditions were. This change in size of groups and increase in number of large groups was particularly striking in Samples A, B and C and was clearly evident even on casual examination of the smears. Non-motile bacteria of the micrococcus type had the greatest tendency to form the large-sized clumps, as would naturally be expected.

These findings have an important bearing on the proper procedure to use in making microscopical counts showing (1) that it is important to dry the films of milk as quickly as possible and (2) that dry films of milk may be kept with impunity, if protected, and stained at leisure.

Dissolving the fat.— Objection has been made by Skar[35] to dissolving the fat out of the milk smears because of the possibility that the dissolving of the fat may mechanically remove some bacteria from the dried film of milk. The same objection holds in lesser degree in regard to later steps in the process such as washing in alcohol, staining, washing in water and the like. This objection was considered when the present technique was originally devised but was disregarded when it proved to be impossible to demonstrate that bacteria were lost in this way. Abundant proof has now been secured from comparative counts made with the plate and microscopical methods which shows that this loss, if any, is negligible. Apparently the dried casein and milk albumin act as perfect fixatives. This result is not surprising when it is remembered that the bacteria in the milk do not occur in the fat drops but float between them in a colloidal solution which readily coagulates on heating or in alcohol, embedding the bacteria in a semisolid coagulum which is not dissolved nor attacked in any subsequent process used in staining the films of dried milk.

Xylol has generally been used in our work as a fat solvent but ether, turpentine, gasoline or other fat solvents may be substituted where more convenient to use them. All act very quickly, but prolonged immersion of the dried films in these liquids causes no harm.

Preparing and staining milk smears without removal of the fat.— Alex. Klein[36] was probably the first to suggest the staining of bacteria in liquid suspensions for use in making dried films for counting bacteria. A similar technique has been adapted to staining bacteria in milk by Skar[37] which is also very similar to the technique used

[35] See footnote 25.
[36] See footnote 9.
[37] See footnote 25.

by Doane[38] for staining cells in milk. By staining the bacteria in the milk before the dried films are prepared it becomes possible to make these in suitable condition for immediate microscopical examination. Theoretically this procedure is preferable to the one discussed in this bulletin, for it removes all possibility of danger of loss of bacteria through manipulation of the preparation; but certain other difficulties arise in making milk smears which so completely outweigh this theoretical advantage that it becomes necessary to disregard it. Experimentation has shown that the stained bacteria are not only obscured in such milk films by the fat drops, as already pointed out by one of us,[39] but also bacteria may be and are frequently overlooked in the smears because they have not stained.

Four tests in addition to those just referred to will be sufficient to show the conditions which may prevail: (1) Two slides were prepared from whole milk to which carbolated methylene blue had been added in accordance with the directions given by Skar. One of these was restained according to the method discussed in this bulletin. The count on the first slide showed 110,000 groups of one or more bacteria per cubic centimeter and 670,000 individual bacteria per cubic centimeter. The restained slide showed 1,160,000 groups and 2,840,000 individual bacteria per cubic centimeter. (2) A sample of whole milk, which was nearly sour with a predominant *Bacterium lactis acidi* flora, was handled in a similar way. A count of the film made according to Skar's technique showed 282,000,000 groups and 346,600,000 individual bacteria per cubic centimeter. The restained film showed 756,000,000 groups and 1,225,400,000 individual bacteria per cubic centimeter. In both instances it was impossible to decide how much of the increase was due to the removal of the fat drops and how much was due to the staining of unstained bacteria.

(3) A trial was then made with skim milk free from fat drops and known to contain large numbers of bacteria. The Skar film showed 15,960,000 groups and 18,060,000 individual bacteria per cubic centimeter, the predominant organism being a colon-like rod largely appearing as single individuals and well scattered on the field. An unstained background showed rod-like bodies of a similar size. The restained film showed at once that these were bacteria and the count rose to 558,000,000 groups and 567,900,000 individual bacteria per cubic centimeter. In this instance there can be no question but that faulty staining was responsible for the lower count obtained from the first film. (4) A fourth trial with a skim milk containing fewer bacteria gave similar results. The count on the Skar film showed 160,000 groups and 240,000 individual bacteria per cubic centimeter. The count on the restained film showed 540,000 groups and 1,280,000

[38] Doane, C. F. Leucocytes in milk and their significance. Md. Agr. Exp. Sta., Bul. 102, 1905.

[39] See p. 32 in reference given in footnote 1.

individual bacteria per cubic centimeter. The increase in number was clearly due to the staining of bacteria unaffected by the first attempt at staining.

Danger of overlooking bacteria due to faulty staining.— The discovery of this difficulty in connection with attempts to stain the bacteria in the milk itself raised the question whether the method of staining described in this bulletin succeeded in bringing out all of the bacteria. The need of investigating the matter was further emphasized by occasional results secured where comparative plate and microscopic counts were made. The counts of the number of individual bacteria in milk by means of the microscope are almost invariably several times greater than plate counts made on the same milk but infrequently this relation is reversed and rarely comparative counts are secured where the plate count is very much higher than the microscopic count. Thus in the series of 450 comparative counts reported in Bulletin 373 there were two of this sort: One in which the plate count was 260,000 while the microscopic count was 100,000 and another in which the plate count was 2,150,000 and the microscopic count 960,000. Two striking instances of the sort have occurred in later comparative work, in one of which (microscopic count — 15,000, plate count — 1,500,000) a careful recount made by the microscopical method failed to reveal any explanation of the discrepancy while in the other case spore-like, unstained bodies which could be easily overlooked were found in the smear. An examination of the plates made from the same sample showed spore-forming bacteria to be present.

These findings would indicate that faulty staining of dried films plays a very minor role in causing errors.

Fixation in alcohol.—It is necessary to dry the slides after removing the fat because the solvents used do not mix with ordinary alcohol. Absolute alcohol may be used as an intermediary in passing from the fat solvent to the alcohol but is expensive and unnecessary. Seventy per ct. grain alcohol is strong enough to serve the purpose, but stronger alcohols may be used equally well or denatured alcohol may be substituted for the pure grain alcohol. Immersion in alcohol should be long enough to change the opaque whiteness of the smear to a semitransparent appearance. In our work it has occasionally happened that dried films of milk prepared from the milk of cows approaching the end of the lactation period have proved soluble in alcohol but this is an unusual condition which at once becomes evident on placing the film in alcohol.

Staining.—In practical work, the slides are usually transferred directly from the alcohol to the saturated methylene blue but they may be dried at this stage without injury. Other stains may be used but none have proved as satisfactory as the aqueous solution of methylene blue. Stains containing alkalis should be avoided as they dissolve the smears. Loeffler's methylene blue, as commonly

used in bacteriological laboratories, does not contain sufficient alkali to dissolve the smears but should be avoided as there is no advantage in its use and frequently through carelessness or intent it contains enough alkali to cause trouble. Old stains containing precipitates should never be used as these may cling to the smears and cause trouble.

Slides.—For many purposes, it has been found to be convenient to use ordinary 1 x 3-inch microscope slides, duplicate, triplicate or even quadruplicate smears being placed on the same slide. Various methods of marking out the one square centimeter areas have been tried but none have been found to be more convenient than to place the slide over counting plates or other objects, the surface of which has been ruled in square centimeters. In routine work it has been found convenient to use larger-sized glass plates, cut from ordinary window glass and secured at any hardware store at a very small cost, in place of the 1 x 3-inch slides. In order to use as large a slide as possible on the stage of the microscope, a special mechanical stage was secured in which nearly the entire surface of 2 x 4½-inch slides could be examined. Special slides were also secured from Bausch and Lomb Optical Co. at a small cost of the same size as those used for mounting the smears on which 16 square centimeter areas are conveniently placed (see Fig. 3). These are used as guide plates, being placed under the slide on which the smears are to be mounted when in use. The margins of the window glass slides on which the smears are mounted are etched by a sand blast along a strip about ¼ inch in width (Fig. 4) in order to allow lead pencil labeling. These slides are filed away in an ordinary card filing case, 2-inch library cards being placed between the slides. Notes are frequently entered on these cards. In our routine work, only one smear is made from a sample so that each slide carries the record of 16 samples of milk. The slides may be preserved indefinitely giving a valuable record for later comparisons or for reference in cases of dispute.

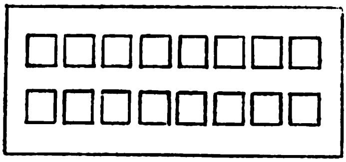


FIG. 3.—SPECIAL GUIDE-PLATE. (2x4½ ins.)

FIG. 4.—SPECIAL MICROSCOPE SLIDE WITH ETCHED MARGINS FOR LABELING. (2x4½ ins.)

STANDARDIZATION OF THE MICROSCOPE.

If the proper ocular is selected for use with the oil-immersion lens and the draw tube adjusted, the area of the microscopic field

can be made of such a size that it gives a simple figure for use in computations. Thus if the diameter of the field is .16 millimeter the area covered by each field of the microscope is approximately 1–5000 square centimeter (actually 1–4975 square centimeter). Under these conditions each bacterium seen in a field is equivalent to 500,000 bacteria per cubic centimeter of milk, or if the total number of bacteria seen in 100 fields of the microscope are counted, each individual seen is equivalent to 5,000 per cubic centimeter. This gives a somewhat higher magnification than is necessary for counting bacteria.

After much experience, it has, therefore, become our custom to use a field of such a size that it gives a 300,000 factor for computation. This is secured by adjusting the draw tube so that the diameter of the field is .205 millimeter. In this case the number of bacteria in a single field of the microscope multiplied by 300,000 (actually 302,840), or the total number of bacteria in thirty fields multiplied by 10,000, or the total number of bacteria in 100 fields multiplied by 3,000 gives the total number of bacteria per cubic centimeter.

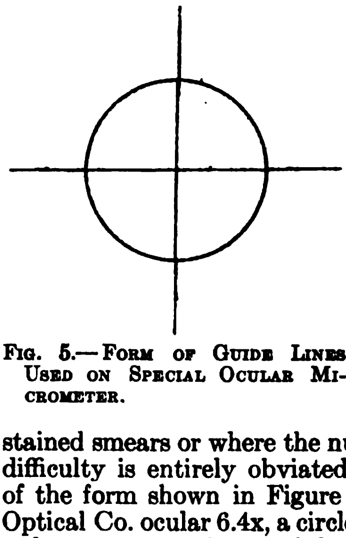


FIG. 5.—FORM OF GUIDE LINES USED ON SPECIAL OCULAR MICROMETER.

There is an objection to using the whole field of the microscope for observation in that only the center of the field of any oil-immersion lens gives sharp definition. With as low a magnification as that which gives the 300,000 factor, poor definition at the edges of the field does not cause serious trouble except with poorly stained smears or where the number of bacteria present is large. This difficulty is entirely obviated by using a special ocular micrometer of the form shown in Figure 5. For use with a Bausch and Lomb Optical Co. ocular 6.4x, a circle of 8 millimeters diameter will be found to be very convenient. If the draw tube is so adjusted that the diameter of the circle becomes .146 millimeter then the factor necessary for computation becomes 600,000 (actually 597,708). Ocular micrometers bearing additional circles are convenient for use in some cases but the markings shown are sufficient for ordinary use. Additional lines are troublesome as they tend to obscure bacteria.

DIFFICULTIES INVOLVED IN COUNTING.

The chief immediate practical value of this technique is for use in the rapid grading of milk. For routine work with samples of fresh milk, a search through twenty to thirty fields of the microscope is sufficient to answer the question whether so few bacteria are

present that none can be readily found, whether they occur in scattering groups, or whether they are so abundant that every field of the microscope shows them in large numbers. These three conditions correspond roughly to the three grades of milk established by the New York State and the New York City Codes. The picture presented to the eye, when these preparations are viewed under the microscope, is similar to that presented by the colonies on petri plates. Smears which show intermediate conditions must be examined carefully and counting resorted to if the sample is to be graded accurately. The number of these border line samples is ordinarily relatively few but will vary according to the general quality of the milk which is being sampled.

The use of microscopical methods for making exact counts involves certain difficulties not met with where these techniques are used for rapid grading. It requires nearly as much work to make an accurate count with a microscopical method as with the plate method. However, for certain classes of research work they are essential methods, as it is only in this way that the total number of individual bacteria can be determined. Moreover, counts may be secured in very much shorter time.

In making exact counts the following more or less arbitrary rules have been drawn up:

1. Incompletely divided forms are to be counted as two individuals.
2. As careful estimates as possible are to be made of the compact masses of micrococci or other forms but all counts made from smears containing such clumps shall be regarded as of doubtful accuracy.
3. Bacteria within cells are to be counted.
4. Single individual objects in high-grade milk having the appearance of bacteria are to be regarded as doubtful bacteria especially if they have the appearance of cocci or if they differ in morphology from the other undoubted bacteria present. These bodies may be chromatin masses from the disintegrating nuclei of tissue cells, or possibly dead udder cocci. They are rarely, if ever, present in large numbers and are never troublesome except occasionally in high-grade milks and then only when exact counts are desired.

In making counts of groups of bacteria under the microscope, it is our custom to count as separate groups all masses of bacteria which look as if they would break apart in making dilutions so as to form separate colonies on the plates, whether containing one bacterium or thousands. This rule leaves much to be desired, as its interpretation depends entirely upon the judgment of the individual who makes the count; but no better statement of the case has suggested itself.

The number of fields which should be counted is dependent upon the accuracy desired. Experience has shown that it is scarcely ever worth while for one person to count over 100 fields on a smear. Additional accuracy can be better secured by duplicate sampling

or by having two or more persons make counts from the same preparation. A view of thirty fields gives a sufficiently accurate count in practically all cases and remarkably constant group counts are obtained in high-count milks where only five fields are counted. Counts of individuals are much more apt to be variable than are counts of groups because of the widely variable number of individuals in a group.

POSSIBLE INACCURACY OF COUNT.

Since it has repeatedly proved possible to make bacterial counts of groups by both the plate and microscopic methods which give very similar results especially where samples of milk are used containing a predominant colon or lactic acid flora, it must be admitted that both methods are capable of making fairly accurate counts of the numbers of groups of bacteria present when all conditions are favorable. (See the results secured from the analysis of Sample 85 in the series of analyses made in New York City[40] for an example of this sort. This milk had a predominant *Bacterium lactis acidi* flora). However, since widely discrepant counts may be and are frequently found, it is also equally clear that either or both methods of counting bacteria are subject to errors due either to faulty manipulation or to inherent differences in the milk sampled. There is likewise the possibility that both of these causes may play a part in bringing about the annoying discrepancies which occur. Further investigations are needed before entirely satisfactory explanations of these discrepancies can be given.

Certain chances of error are present in the microscopical technique, the most important of which seem to be:

1. Faulty measurement of the original sample of milk.
2. Growth of bacteria after the sample is taken, especially in the drop of milk while it is drying.
3. Inaccurate counting due to carelessness, poor preparations, differences in judgment as to what constitutes an individual or group, or to mistaking objects for bacteria which are not bacteria.
4. Irregular distribution of bacteria in clumps of irregular sizes. Where a milk contains clumps of bacteria of large size, it is impossible to make a satisfactory count of the number of individual bacteria.

Sources of error commonly urged which do not seem to play any important part in causing errors are:

1. Error due to small amount of milk examined. This error averages no larger for the microscopic technique than for the plating technique. The amount of milk ordinarily examined by the microscope is less than that examined by the plate count in low-count milks but is larger in the case of high-count milks.

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[40] See p. 2386–7 in reference given in footnote 24.

2. Errors due to washing bacteria out of smears, or to adding them by the use of unsterilized pipettes, washing from smear to smear, and the like.

3. Errors due to the counting of dead bacteria. Very few dead bacteria occur in fresh, unpasteurized milks. Moreover, if they do occur, they are as significant in interpreting the past history of the milk as are living bacteria.

PRACTICAL APPLICATION OF THE MICROSCOPICAL EXAMINATION OF MILK TO COMMERCIAL GRADING.

In practical use, it has been found possible to determine whether a given sample of milk will give a plate count less than 60,000, less than 200,000 or less than 1,500,000 with a relatively small percentage of error. Thus this technique has a large field of usefulness for milk dealers who wish to determine quickly and cheaply whether the milk which they are handling will conform to requirements which they are compelled to meet. At least three milk companies in the State have, within the past year, been making use in this way of the microscopical technique here described with such satisfactory results that they expect to continue and extend its use.

The Station has at the same time been making a practical test of the technique in an experimental way in connection with local milk control work. After a preliminary trial, in which entirely satisfactory results were secured, contracts were drawn up between two local milk companies and the producers making the microscopical examinations of their milk by the Station the basis for payment. This system has now been in force since April 1, 1915, and has given satisfaction to all parties concerned. Frequent comparative counts made by the microscopical and the plate methods have given clear indication that the farmers received fairer treatment from the use of the microscopical method of grading than they would have received if the plate method of grading had been used. This has come about largely because it has been possible to make a weekly examination of each individual can of milk brought in by each man. Likewise, fairer judgment as to the quality of the milk is secured where it is possible to recognize not only the numbers but also the morphology of the bacteria present as is always the case when the milk is examined by the microscopical method. In this way several instances have been detected where the sole cause of the high-count milk brought in by individual farmers was due to the milk of cows with a streptococcus infection. No difficulty was encountered in stopping the presentation of this type of milk at the milk stations, for the farmers were only too glad to find the source of the trouble which caused their income from the sale of the milk to become less.

In this milk control work one person prepares his collecting case, goes to the milk station one mile distant and collects forty to seventy samples of milk, returns to the laboratory, prepares the smears, examines them and has the results of the examination ready to be mailed to the individual farmers within five hours. During one week every can of milk delivered at one of the milk stations was examined, all of the work being done by one person.

OTHER APPLICATIONS OF THE MICROSCOPICAL METHOD OF COUNTING BACTERIA.

Since the method of counting bacteria discussed in this bulletin was devised, many inquiries have been made asking whether a similar method could not be used for pasteurized milk, fermented and sour milks, butter, cheese, whey, catsup, soil and a great variety of other substances. There is no reason why microscopical methods cannot be used for these substances provided accurately measured quantities of these materials can be so prepared and stained as to present the bacteria clearly differentiated from the surrounding objects and evenly distributed over the preparations. In many cases the presence of dead bacteria in large numbers may complicate matters. But as shown by Winslow and Willcomb[41] errors in count from this source are not as great as might be expected because of the fact that dead bacteria quickly lose their staining power. This fact has already been made use of by Proca,[42] and has also been tested by Kayser,[43] in attempting to so stain bacteria as to distinguish between the living and dead individuals. Various investigators have suggested the use of gelatin, albumen, or collodion as materials for use in preparing emulsions so that they will adhere to the slide. We have found that sterilized skim milk may be used in this way for diluting whey, high-count fresh milks, and the like. The sterilized skim milk should be prepared from milk known to contain very few bacteria and sterilization should be prolonged, as this causes the few bacteria present to disintegrate.

In some instances it may be better to examine the material in liquid form, in which case some form of the Thoma-Zeiss method for counting blood cells is the best technique now available.

Counts made by means of the microscope are likely to give much valuable information especially where used in connection with the plating technique. The microscopical examination shows at once whether the plate count really stands for a count of individual bacteria or whether it stands for a count of groups of bacteria. It

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[41] See footnote 16.

[42] Proca, G. Sur une coloration differente des bact. mortes. *Compt. rend. Soc. d'biol.*, Paris. 66:148–150. 1909.

[43] Kayser, Heinrich. Die Unterscheidung von lebenden und totem Bakterien durch die Farbung. *Centbl. Bakt.*, Abt. I. Orig., 62:172–176. 1912.

also shows whether bacteria or spores are present in greater numbers than are revealed by the plate method. If such a condition holds then further investigation will show whether the discrepancy is due to the presence of dead bacteria or to the presence of bacteria which do not grow on the plates. Used in this way, microscopical methods of counting bacteria are likely to become much more valuable research methods in the future than they have been in the past.

5

ARE SPORE-FORMING BACTERIA OF ANY SIGNIFICANCE IN SOIL UNDER NORMAL CONDITIONS?*†

H. JOEL CONN.

SUMMARY.

1. The number of spore-forming bacteria in soil is relatively constant and is about the same in all the soils studied. Three of the spore-forming bacteria always present in soil — *B. mycoides*, *B. cereus*, and *B. megatherium* — were selected for the purpose of comparison, because their colonies on gelatin plates are quite readily distinguishable. The total number of these three organisms, as determined by means of gelatin plates, proved to be between 400,000 and 1,500,000 per gram in the soils studied. They always comprised less than 10 per ct. and usually less than 5 per ct. of all the colonies developing on gelatin.

2. When soil-infusion was heated, before plating, at a temperature (75–85° C.) high enough to kill the vegetative forms of bacteria, nearly if not quite as many colonies of these spore-forming bacteria developed as when it was plated unheated. In about one-third of the cases, indeed, their numbers were actually slightly higher on the plates made after heating; although all such differences undoubtedly lay within the limits of the experimental error. This suggests that these bacteria occur in normal soil as spores rather than in a vegetative state.

3. No increase in the total number of these organisms nor decrease in the number of their spores could be detected in a pot of soil to which fresh manure had been added.

4. These results throw considerable doubt on the common assumption that these organisms are important ammonifiers in the soil. They raise the question as to what possible soil conditions favor their growth and multiplication.

INTRODUCTORY.

Among the best known of the soil microörganisms are the spore-forming bacteria. They have been described as soil bacteria ever since the first bacteriological investigations of soil were made; and a more thorough taxonomic study of them has been made than of any other bacteria except those that have sanitary significance.

* Read before the Society of American Bacteriologists at Urbana, Ill., December, 1915.

† A reprint of Technical Bulletin No. 51, March, 1916.

It is seldom, however, that they comprise more than 10 per ct. of the total flora of soil. In 1903 Hiltner and Störmer [1] recognized three groups of colonies upon gelatin plates made from soil: liquefiers, non-liquefiers and Streptothrix. The liquefiers averaged about 5 per ct. of the total flora. The ordinary spore-forming bacteria in soil are all rapid liquefiers and must have been included in this 5 per ct. mentioned by Hiltner and Störmer. Similar results have been obtained by various other investigators.

The spore-forming bacteria, *B. mycoides*, *B. cereus*, and *B. megatherium*, are practically always present in soil and have always been considered characteristic and important soil organisms. These bacteria develop on gelatin or agar plates much more rapidly than those which comprise the other 90–96 per ct. of the soil flora, and form large, striking colonies. They are among the largest of all bacteria and have an unusually interesting morphology, so it is not surprising that they have been studied the most extensively of all the soil organisms growing in ordinary media, in spite of the fact that they are not very abundant in soil. In nitrogenous culture media these bacteria grow rapidly and cause a vigorous ammonification. For this reason they have been assumed to be the important ammonifiers of the soil.

This assumption was accepted as reasonable when the author began to study the bacteria of soil. The first suspicion to the contrary came when it was noticed that the numbers of these spore-formers in the soil remained almost constant under all conditions, while the other bacteria varied in number according to the moisture content, aeration of the soil, or other conditions. The most natural explanation for this seemed to be that these bacteria lived over unfavorable conditions in the form of spores. It was soon realized, however, that this argument could not be carried to its logical conclusion without assuming that spore-formers were normally present in soil only as spores; in which case naturally their numbers would not vary.

EXPERIMENTAL.

A series of tests to investigate this matter has been made at the New York Experiment Station during the past year. The method used depended upon the fact that spores can resist higher temperatures than the vegetative forms. To determine the number of spores and vegetative rods present in any soil, one lot of diluted soil-infusion was plated in the ordinary manner, while a parallel lot of the diluted infusion was heated before plating for 15 or 20 minutes at 75–85° C. Then the colonies of the three spore-bearers, *B. mycoides*, *B. cereus* and *B. megatherium*, appearing on each set of plates, were counted.

[1] Hiltner, L., and Störmer, K. Studien über die Bakterienflora des Ackerbodens, mit besonderer Berücksichtigung ihres Verhaltens nach einer Behandlung mit Schwefelkohlenstoff und nach Brache. *Kaiserliches Gesundheitsamt, Biol. Abt. Land-u. Forstw.* 3: 445–545. 1903.

The colonies that developed from the heated infusion were assumed to arise from spores only; while in the case of the unheated infusion colonies might arise from vegetative rods as well.

The culture medium used in these tests was gelatin.[2] On this medium each of the three organisms investigated produced a fairly characteristic colony[3], so that it was ordinarily possible to distinguish them with little difficulty from non-spore-formers on the plates made from unheated infusion. Plates were incubated at 18° C. for seven days. This length of incubation was necessary in order to allow the late colonies (particularly of *B. megatherium*) to appear. The chief disadvantage of such a long incubation was that *B. mycoides* and *B. cereus* often had time to liquefy the plate completely unless high dilutions were used. Dilutions of 1–20,000 and sometimes even 1–100,000 or 1–200,000 were necessary in order to avoid this trouble. At such dilutions the numbers of colonies of the spore-forming bacteria were so few that a long series of plates had to be made in order to obtain a reliable count; and even then no significance could be attached to variations in the count unless they were quite large.

In the first of these tests a temperature of 85° was used; but later it was learned that at temperatures only about ten degrees higher than this large numbers of the spores were killed and it was suspected that even 85° might destroy some of them. For this reason 80° was used instead for a while, and in the last tests 75° was used. To test the efficiency of this last temperature the bacteria developing on the plates after heating the infusion were studied, and it was found that nothing but spore-bearing bacteria had survived (leaving out of account an occasional colony of some non-spore-forming type that might easily be due to air contamination).

The greatest source of error in this method which could not be avoided is the possibility that the bacteria investigated may occur in soil in clumps or chains instead of as isolated individuals. It is possible that clumps of bacterial spores can be broken up by the action of heat, which would tend to increase the count in the heated infusion provided clumps do occur in the soil. No increase of any appreciable size has ever been observed, however; and indeed, so far as microscopical examinations of soil have been made, no evidence has been obtained of chains or clumps of organisms of this type. For this reason this possibility of error did not seem great enough to invalidate the conclusions.

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[2] Twelve per ct. of gelatin (Gold Label) dissolved in tap-water and clarified with white of egg.

[3] Although it was found possible to recognize these colonies after considerable experience, the colony produced by each organism varies so much that it is not possible to give descriptions that could be followed by anyone wishing to check up the work. There is so much confusion in the nomenclature of spore-forming bacteria that these same three names may even be applied to other types of bacteria by other bacteriologists. Cultures of the organisms studied in this work will gladly be sent to anyone wishing to identify them.

TABLE I.— NUMBER OF SPORE-BEARING BACTERIA IN SOIL INFUSION, BEFORE AND AFTER HEATING.

Determined by means of gelatin plates.

Date	Type of Soil, and Its State of Cultivation.*	Temperature used.	Number of B. mycoides, B. cereus and B. megatherium per Gram. In unheated soil-infusion.	In heated soil-infusion.	Difference in favor of the unheated soil-infusion.
1915.					
Jan. 23	Dunkirk silty clay loam. Potted. Fallow	85°	900,000	370,000	+530,000
Feb. 10	Dunkirk silty clay loam. Cultivated	85°	850,000	600,000	+250,000
Feb. 19	Dunkirk silty clay loam. Potted. Fallow	85°	900,000	430,000	+470,000
Feb. 25	Dunkirk silty clay loam. Sod	85°	700,000	875,000	—175,000
Mar. 10	Dunkirk silty clay loam. Sod	85°	425,000	40,000	+385,000
Mar. 11	Dunkirk silty clay loam. Sod. Sub-soil	85°	625,000	550,000	+ 75,000
Mar. 13	Volusia silt loam. Cultivated	85°	550,000	275,000	+275,000
Sept. 16	Dunkirk silty clay loam. Sod	85°	400,000	425,000	— 25,000
Sept. 21	Dunkirk fine sand. Sod	80°	725,000	680,000	+ 45,000
Sept. 21	Dunkirk fine sand. Cultivated	80°	250,000	625,000	—375,000
Sept. 24	Ontario fine sandy loam. Sod	80°	1,100,000	900,000	+200,000
Sept. 24	Ontario fine sandy loam. Cultivated	80°	975,000	1,100,000	—125,000
Oct. 19	Dunkirk silty clay loam. Freshly potted	80°	525,000	400,000	+125,000
Oct. 20	Honeoye stony loam. Sod	75°	800,000	1,150,000	—350,000
Oct. 20	Honeoye stony loam. Cultivated	75°	750,000	1,200,000	—450,000
Oct. 22	Dunkirk gravelly loam. Sod	75°	425,000	550,000	—125,000
Oct. 22	Dunkirk gravelly loam. Cultivated	75°	1,500,000	1,450,000	+ 50,000
Nov. 9	Dunkirk silty clay loam. Potted	75°	700,000	1,050,000	—350,000
Dec. 7	Dunkirk silty clay loam. Potted	75°	800,000	650,000	+150,000
Dec. 7	Dunkirk silty clay loam. Dried. Potted	75°	775,000	650,000	+125,000

Dec. 7	Dunkirk silty clay loam. Manured. Potted	75°	1,350,000	1,050,000	+300,000
Dec. 7	Dunkirk silty clay loam. Manured and dried. Potted	75°	1,050,000	1,000,000	+ 50,000
Dec. 25	Dunkirk silty clay loam. Potted	75°	925,000	525,000	+400,000
Dec. 25	Dunkirk silty clay loam. Dried. Potted	75°	550,000	200,000	+300,000
Dec. 25	Dunkirk silty clay loam. Manured. Potted	75°	1,600,000	1,450,000	+150,000
Dec. 25	Dunkirk silty clay loam. Manured and dried. Potted	75°	400,000	375,000	+ 25,000
	Average, first 8 tests	85°	670,000	445,000	+230,000
	Average, 9th to 13th test, inclusive	80°	715,000	740,000	— 26,000
	Average, last 13 tests	75°	894,000	869,000	+ 21,000
	Average for last 18 tests	80° and 75°	844,000	833,000	+ 5,300
	Average for all 26 tests	....	788,000	712,000	+ 76,000

* The soil nomenclature of the Bureau of Soils of the U. S. Department of Agriculture is used in this table. The soils mentioned are described in the Soil Survey of Ontario County, New York, published by this Bureau.

A series of twenty-six tests was made. The results are given in Table I. The most striking fact to be observed at first glance is the regularity of the numbers of these organisms in the unheated infusion. The highest count is 1,500,000 and the lowest 400,000. Compared with bacterial counts in general, these show remarkable regularity, especially when it is considered that the soils varied from poor sand to richly manured loam and that the counts were made on plates of such high dilution that comparatively few colonies were obtained on each plate. The counts obtained from the heated infusion are not quite as regular; but if the first eight tests are excluded — in which the use of 85° may have killed a few spores — there is scarcely any more variation than in the case of the unheated infusion.

Because of this regularity in the counts it is possible to obtain general averages that can be fairly compared with each other. The average count from the unheated infusion is 788,000, from the heated infusion 712,000. This slight difference indicates that there are very few, if any, of the organisms present in soil in a form that can be killed by the temperatures used. Studying the figures more closely it will be noticed that the greatest differences between the two counts occurred in the first eight tests, in which 85° was used. The average count in these first eight tests, unheated, was 670,000, while the average count, heated, was 445,000. In the last eighteen tests, however, both counts averaged nearly the same, 844,000 and 833,000, respectively.

A more careful analysis of the data yields similar results. The last column of the table shows the difference between the two counts with a plus sign before it if the count obtained from the unheated infusion was the higher, with a minus sign if that from the heated infusion was the higher. It will be seen that there are eighteen cases in which the plus sign is used, and in these cases the greatest difference was 530,000, or if the tests are excluded in which 85° was used, it is 400,000. On the other hand in the eight tests in which a greater count was obtained from the heated infusion there is one difference as large as 400,000. The average difference between the two counts is 76,000 in favor of the unheated infusion; while if the first eight tests are excluded it is only 5,300, an almost negligible figure.

It might be concluded from these data that some vegetative forms do exist in normal soil and for this reason a higher count was obtained eighteen times from the unheated infusion; while in the other eight cases a higher count was obtained from the heated infusion because clumps were broken up by the heat. It is improbable, however, that these two factors should ordinarily so nearly neutralize each other; nor is it possible, if this explanation is used, to account for the greater average difference in the first eight tests than in these in which lower temperatures were used. It seems more reasonable

to explain most of the differences in either direction as lying within the experimental error — a perfectly plausible assumption in view of the high dilutions used; or if this is not enough to explain all the cases in which the higher count was obtained from the unheated infusion, to assume that an occasional less resistant spore was killed by the heat. The evidence all seems to indicate that the three organisms investigated do not occur in soil under normal conditions as active vegetative forms, but as spores. It is true that there are other spore-forming bacteria in soil besides these three types, in regard to which definite data could not be obtained because their colonies are not characteristic enough to be recognized with certainty; but none of them are as constantly present as the three types studied, and what evidence is at hand suggests that the same facts are true in regard to them as in regard to *B. mycoides*, *B. cereus* and *B. megatherium*.

It stands to reason, however, that these bacteria, so universally present in soil, must grow and multiply under some natural conditions. It is known that they ordinarily thrive in the presence of organic matter; so it seemed not improbable that they would multiply if manure were added to soil. A single experiment has been undertaken to test out this point, but with negative results. In a pot of soil, mixed with a heavy application of fresh horse manure, kept under observation for two months, there was at first a very great increase in the number of non-spore-bearers, but no appreciable multiplication of spore-formers; nor was there any decrease large enough to be detected in the number of actual spores. Meanwhile the odor of the soil was enough to show that ammonification was vigorous. It is perfectly possible that a repetition of this test might yield different results; but evidently this experiment did not furnish the right conditions for the growth of the spore-forming bacteria. Also it is plain that ammonification can take place without them.

These results leave our knowledge as to the significance of spore-forming soil bacteria in a rather unsettled state. It has been quite generally taken for granted in the past that they are active in soil and of great importance. Perhaps their striking appearance in plate culture has led to the assumption that they could grow with equal vigor in soil. Yet they comprise but a small part of the soil flora, and even at that they do not seem to be present in vegetative form under normal conditions. Spores are generally regarded as inert.

Nevertheless these spore-forming bacteria of the soil do not decrease in numbers, and spores cannot live forever. Their occurrence in soil cannot be due to accidental contamination, or their numbers would not be so constant. If it is true, as these results indicate, that they are of practically no importance under normal field conditions, it becomes a matter of much interest to learn under what conditions they can become active and multiply.

A POSSIBLE FUNCTION OF ACTINOMYCETES IN SOIL.*†

H. JOEL CONN.

SUMMARY.

1. In general more colonies of Actinomycetes develop on plates made from sod soil than on those from cultivated soil. The average ratio between their numbers in neighboring sod and cultivated spots in the same soil type is slightly over 2:1. The maximum ratio is about 6:1.

2. Actinomycetes average about 38 per ct. of the total flora of sod soil, as determined by means of gelatin plates, but only about 20 per ct. of the total flora of cultivated soil.

3. In a study of three neighboring spots in a single soil type it has been found that Actinomyces colonies not only appear in greater numbers from sod than from cultivated soil, but also in greater numbers from old sod than from sod only two or three years old.

4. This relation has been found to hold with very few exceptions. In the isolated cases where more Actinomyces colonies have developed from a sample of cultivated soil than from the corresponding sample of sod soil, the ratio has never been greater than 1.8:1.

5. Although the reason for this difference in numbers has not been learned, a probable explanation seems to be that Actinomycetes are active in the decomposition of grass roots.

INTRODUCTORY.

It is not generally agreed whether Actinomycetes are to be classed with bacteria or with molds. They are thought to belong with the Hyphomycetes by some mycologists; but those that occur in the soil have generally been considered in connection with the bacterial flora rather than with the soil fungi. The reason why they have been studied by soil bacteriologists may be partly because Actinomycetes can be handled by much the same methods as the lower bacteria; and partly because both of these groups seem to be much more numerous in normal soil than molds proper.

The abundance of Actinomycetes in soil has been recognized for some time. In 1903 Hiltner and Störmer[1] showed that of the

* Read before the Society of American Bacteriologists at Urbana, Ill., December, 1915.

[1] Hiltner, L., and Störmer, K. Studien über die Bakterienflora des Ackerbodens, mit besonderer Berücksichtigung ihres Verhaltens nach einer Behandlung mit Schwefelkohlenstoff und nach Brache. *Kaiserliches Gesundheitsamt, Biol. Abt. Land- u. Forstw.* 3:445–545. 1903.

† A reprint of Technical Bulletin No. 52, March, 1916.

colonies developing on gelatin plates from normal soil, 5 per ct. were ordinarily liquefiers, 70 per ct. non-liquefiers, and 20 per ct. Streptothrix (a name often, although incorrectly, applied to this group). Probably everyone who has plated soil in gelatin, provided he has incubated his plates long enough for the slow-growing organisms to appear, will recognize these figures as typical of ordinary soil.

Perhaps the most interesting recent work on soil Actinomycetes is that of Krainsky[2] in 1914. It contains a valuable classification of these organisms and shows that the reason why few species have been distinctly recognized in the past is because the Actinomycetes require special media in order to bring out their specific characteristics. His further contention, however, that these special media are necessary in order to show the abundance of Actinomycetes in soil is not correct. With his special media he claims to have found as many as 20,000 per gram of soil, but overlooks the fact that Hiltner and Störmer (loc. cit.) found as many as 2.5 millions per gram. Moreover, in the work that forms the basis of the present paper two or three million per gram has proved to be a very common figure, while on certain occasions the number has reached 12 to 14 million. Occasionally over half the colonies developing on gelatin have been Actinomycetes — this in spite of the fact that Krainsky claims their growth to be suppressed by ordinary media.

The great abundance of Actinomycetes in soil has led to many speculations as to their significance. It has often been stated that they are active agents in the decomposition of organic matter; but their part in this process has not been definitely studied. Beijerinck[3] showed that one type was often present in the corky layer of various roots. He called this type *Streptothrix chromogena* after Gasperini[4] who, however, had called it *Actinomycès chromogenus*. This type is one of the most numerous in soil; yet in the light of recent work it must be regarded as a group rather than a species. To this group belongs the causal organism of potato scab. Lutman and Cunningham,[5] indeed, have recently attempted to show that the cause of this disease must be renamed *Actinomyces chromogenus* because it agrees in every particular with Gasperini's description of that organism. This is plainly impossible; for Krainsky (loc. cit.) has shown that at least four separate species agree with the descriptions that have been given to *A. chromogenus*.

This fact brought out by Krainsky is very evident to anyone who

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[2] Krainsky, A. Die Aktinomyceten und ihre Bedeutung in der Natur. *Centbl. f. Bakt.*, Abt. II, 41:649–688. 1914.

[3] Beijerinck, M. W. Ueber Chinonbildung durch Streptothrix chromogena und Lebensweise dieses Mikroben. *Centbl. f. Bakt.*, Abt. II, 6:2–12. 1900.

[4] Gasperini, G. Versuche über das Genus "Actinomyces." Paper presented at the Eleventh International Medical Congress at Rome. Abstract in *Centbl. f. Bakt.*, Abt. I, 15:684. 1894.

[5] Lutman, B. F., and Cunningham, G. C. Potato scab. Vermont Agric. Exper Sta. Bul. 184. 1914.

uses his methods for studying the group. In fact it has proved possible, by the use of other special media [6] besides those described by him, to recognize many more types than those listed in his article. Work is now in progress along this line.

This complexity in the group and the confusion in nomenclature, however, must not hide the fact that an Actinomyces causes potato scab, nor that Beijerinck, approaching the subject from an entirely different angle, has shown them to be associated with the roots of other plants. It is also to be remembered that they are thought to be concerned in the decomposition of organic matter. Some recent observations at the New York Experiment Station bear on this point.

EXPERIMENTAL.

In the course of a qualitative study of the bacteria in certain New York State soils, it was early recognized that there was a great similarity between different soils in the relative numbers of Actinomycetes and lower bacteria present, provided the soils were in the same state of cultivation. Later it also became evident that the Actinomycetes were practically always present in greater abundance in old sod soil than in soil recently cultivated. This difference is shown in Table I, in which the numbers of Actinomycetes found in twenty samples of various sod soils are compared with the numbers occurring in an equal number of samples of cultivated soil. Although it is possible to pick out numerous cases in which the number occurring in some one of the cultivated samples is greater than in some of the sod samples, nevertheless the average number in sod soil is twice that in the cultivated soil. The table also shows that the Actinomycetes averaged 39.4 per ct. of the total flora of sod soil, but only 21.3 per ct. of the flora of cultivated soil. There is only one instance (October 22, 1913) in which the percentage of these organisms in sod soil is as low as their average percentage in cultivated, and only one (January 4, 1911) in which their percentage in cultivated soil is as high as their average percentage in sod.

These figures furnish a strong indication that Actinomycetes are more numerous in sod than in cultivated soil; but even before all the data given in Table I was collected the importance of making a more satisfactory comparison was realized. To do this, a study was made of a considerable variety of soil types;[7] and in order to avoid as many as possible of the other variable factors that might be involved in a comparison of miscellaneous soils, two samples were

[6] The medium which has given the best results of any yet investigated contains: 1,000 c.c. water, 15 g. agar, 10 g. glycerin, 1 g. sodium asparaginate, 1 g. dextrose, 1.5 g. $NH_4H_2PO_4$, 0.2 g, $MgSO_4$, 0.1 g. $CaCl_2$, 0.1 g. KCl, trace $FeCl_3$. Further media are now being tested out that may prove even more satisfactory.

[7] The soil nomenclature of the Bureau of Soils of the U. S. Department of Agriculture has been used in this work. The soils mentioned are described in the Soil Surveys of Ontario and Tompkins Counties, New York, published by this Bureau.

TABLE I.— NUMBER OF ACTINOMYCETES IN MISCELLANEOUS SAMPLES OF SOD AND CULTIVATED SOILS.
Determined by means of gelatin plates.

Sod Soil.				Cultivated Soil.			
Date.	Soil type.	Number per gram.	Percentage of total flora.	Date.	Soil type.	Number per gram.	Percentage of total flora.
			Per ct.				*Per ct.*
Nov. 8, 1911	Dunkirk fine sand........	1,000,000	28.	Feb. 7, 1910	Dunkirk clay loam........	4,000,000	18.
April 29, 1913	Dunkirk fine sand........	3,800,000	38.	May 28, 1910	Dunkirk clay loam........	2,000,000	29.
June 4, 1913	Dunkirk sandy loam.....	2,800,000	36.5	Aug. 20, 1910	Dunkirk clay loam........	2,000,000	23.
Oct. 27, 1913	Muck................	33,000,000	28.	Jan. 4, 1911	Dunkirk clay loam........	6,000,000	40.
April 24, 1913	Ontario fine sandy loam...	8,000,000	36.5	Feb. 8, 1911	Dunkirk clay loam........	4,800,000	35.
May 7, 1913	Loam. Type not known..	3,500,000	35.	Nov. 24, 1911	Dunkirk silty clay loam....	6,300,000	21.5
May 12, 1913	Honeoye stony loam......	8,000,000	43.	Jan. 13, 1912	Dunkirk silty clay loam....	6,000,000	17.5
May 14, 1913	Honeoye stony loam......	8,500,000	30.	Jan. 23, 1912	Dunkirk silty clay loam....	2,800,000	25.
May 26, 1913	Dunkirk fine sandy loam..	7,000,000	56.5	April 24, 1912	Dunkirk silty clay loam....	3,800,000	16.5
June 29, 1913	Ontario loam...........	7,500,000	34.5	April 24, 1912	Volusia silt loam..........	2,200,000	11.5
July 11, 1913	Heavy loam. Type not known...............	12,800,000	38.5	June 5, 1912	Dunkirk silty clay loam....	3,200,000	16.
Sept. 15, 1913	Dunkirk loam..........	4,200,000	54.	June 5, 1912	Volusia silt loam..........	2,600,000	15.5
Sept. 29, 1913	Genesee silty clay loam...	9,000,000	75.	June 20, 1912	Volusia silt loam..........	3,200,000	23.5
Oct. 22, 1913	Genesee loam...........	9,500,000	21.5	Sept. 7, 1912	Volusia silt loam..........	4,000,000	26.6
Nov. 12, 1914	Dunkirk silty clay loam...	6,000,000	42.8	Oct. 11, 1912	Volusia silt loam..........	1,200,000	11.
Nov. 25, 1914	Dunkirk silty clay loam...	8,300,000	37.8	Sept. 28, 1912	Dunkirk silty clay loam....	8,200,000	21.
Nov. 27, 1914	Dunkirk silty clay loam...	4,500,000	45.	Oct. 25, 1912	Dunkirk silty clay loam....	3,300,000	17.5
Feb. 25, 1915	Dunkirk silty clay loam...	10,500,000	23.8	Dec. 3, 1912	Dunkirk silty clay loam....	5,300,000	15.2
Mar. 10, 1915	Dunkirk silty clay loam...	8,700,000	43.7	July 10, 1913	Dunkirk silty clay loam....	2,600,000	13.6
Mar. 11, 1915	Dunkirk silty clay loam...	8,000,000	39.	Aug. 5, 1914	Volusia silt loam..........	3,000,000	30.
	Average............	*7,750,000	39.4		Average............	3,800,000	21.3

* The first four counts in this column are omitted from the average. The total numbers of bacteria per gram are so low in sand and so high in muck that they cannot fairly be included with the rest.

always collected on the same date, from spots in the same soil not more than a few yards apart, one in old sod, the other in a cultivated field. In this series of tests thirty-eight pairs of samples were taken. Also a second shorter series of tests was made to compare the Actinomyces flora of three neighboring spots in a single soil type (Dunkirk silty clay loam), one spot fallow, one in old sod and the third in grass for two or three years only.

All of the counts in these tests were made by means of gelatin plates, because in the earlier work gelatin had been found the best of the various media used for distinguishing Actinomyces colonies from those of the lower bacteria. The gelatin used sometimes contained soil-extract and sometimes tap-water alone.[8] Plates were always incubated for seven days at 18° C. before counting.

The results of the first series of tests are given in Table II. It will be seen that the average number of Actinomycetes in sod soil is nearly twice as high as the average number in cultivated soil; and that they averaged 37.5 per ct. of the total flora in sod soil but only 20.5 per ct. of the flora of cultivated soil. These general averages are much like those given in Table I, but they tell only a part of the story, as it is possible for individual exceptions to obscure the differences in the average. In order to show the differences more plainly, the individual ratios were determined and they were averaged. In the sixth column of Table II is given the ratio of the actual number of Actinomycetes in the sod soil to the number in the corresponding samples of cultivated soil; in the last column of the table is given the ratio of the percentage of Actinomycetes in sod soil to the percentage in the corresponding samples of cultivated soil. A study of these ratios brings out some information not shown by the general averages.

In making a comparison of these ratios it seemed reasonable to assume that those falling between the limits of 1.2:1 and 1:1.2 were so near unity as to indicate no real difference in numbers between the sod and cultivated samples. In the sixth column, giving the ratios of the actual numbers per gram, sixteen cases are listed that fell within these limits. There were only two cases (May 19, 1914, and the third one listed on November 4, 1915) when the numbers in cultivated soil were enough greater than in sod to give a ratio outside these limits; and of these the greatest ratio was only 1:1.8. There were nineteen cases, however, in which the numbers in sod were sufficiently greater than in cultivated soil to give a ratio exceeding 1.2:1; and of them the maximum ratio was 6.4:1. The average ratio of all thirty-eight cases was 2.15:1, which is larger than the ratio between the general averages of columns three and four. The figures which show what percentage of the total flora consisted of Actinomycetes are

[8] For the composition of these media see: Conn, H. J. Culture Media for Use in the Plate Method of Counting Soil Bacteria. N. Y. Agric. Exper. Sta., Tech. Bul. 38, 1914.

TABLE II.— NUMBER OF ACTINOMYCETES IN NEIGHBORING SOD AND CULTIVATED SPOTS OF VARIOUS SOIL TYPES.

Determined by means of gelatin plates.

Date.	Soil Type.	Actual Number per Gram.				Percentage of Total Flora.		
		Sod.	Cultivated.	Difference.	Ratio.	Sod.	Culti-vated.	Ratio.
1913						Per ct.	Per ct.	
Nov. 18	Dunkirk fine sand	3,600,000	3,000,000	600,000	1.2:1	45.	33.	1.4:1
Nov. 20	Ontario fine sandy loam	10,000,000	4,000,000	6,000,000	2.5:1	37.	19.	1.9:1
Dec. 1	Dunkirk fine sand	2,700,000	1,600,000	1,100,000	1.7:1	29.8	19.5	1.5:1
Dec. 5	Ontario fine sandy loam	6,300,000	5,300,000	1,000,000	1.2:1	35.2	21.8	1.6:1
1914								
Jan. 19	Dunkirk fine sand	10,000,000	7,000,000	3,000,000	1.4:1	37.	31.3	1.2:1
Feb. 27	Dunkirk fine sand	9,000,000	2,400,000	6,600,000	3.8:1	15.8	2.2	7.2:1
Mar. 14	Dunkirk fine sand	3,500,000	3,200,000	300,000	1.1:1	35.7	12.2	2.9:1
May 9	Dunkirk fine sand	3,300,000	2,800,000	500,000	1.2:1	33.	22.5	1.5:1
May 18	Ontario fine sandy loam	6,400,000	5,800,000	600,000	1.1:1	32.	21.	1.5:1
May 19	Dunkirk sandy loam	1,800,000	3,200,000	—1,400,000	1 :1.8	36.	35.5	1 :1
May 21	Muck	11,000,000	10,000,000	1,000,000	1.1:1	14.5	19.5	1 :1.3
May 22	Honeoye stony loam	3,200,000	2,800,000	400,000	1.1:1	32.	18.8	1.7:1
May 28	Ontario fine sandy loam	10,500,000	4,300,000	6,200,000	2.4:1	36.8	20.	1.8:1
May 29	Dunkirk silty clay loam	8,000,000	4,000,000	4,000,000	2 :1	40.	19.	2.1:1
Aug. 8	Ontario loam	6,000,000	6,400,000	—400,000	1 :1.1	28.5	25.5	1.1:1
Aug. 27	Dunkirk silty clay loam	9,600,000	1,500,000	8,100,000	6.4:1	60.	14.8	4 :1
Aug. 28	Ontario loam	10,300,000	9,000,000	1,300,000	1.1:1	44.5	28.8	1.5:1
Sept. 1	Dunkirk silty clay loam	12,000,000	2,400,000	9,600,000	5 :1	34.4	14.	2.4:1
Sept. 2	Dunkirk silty clay loam	7,000,000	2,200,000	4,800,000	3.2:1	58.	19.	3 :1
Sept. 10	Dunkirk silty clay loam	8,500,000	2,500,000	6,000,000	3.4:1	47.2	13.8	3.4:1
Sept. 11	Ontario fine sandy loam	4,500,000	1,600,000	2,900,000	2.8:1	45.	16.	2.8:1
Oct. 23	Dunkirk silty clay loam	8,500,000	3,000,000	5,500,000	2.8:1	38.6	10.	3.9:1
Oct. 30	Dunkirk silty clay loam	4,700,000	2,700,000	2,000,000	1.7:1	42.8	15.9	2.7:1
1915								
Sept. 8	Dunkirk silty clay loam	7,500,000	4,500,000	3,000,000	1.7:1	64.	23.	2.8:1
Sept. 16	Dunkirk silty clay loam	12,000,000	2,500,000	9,500,000	4.8:1	48.5	12.5	3.9:1

Sept. 21	Dunkirk fine sand	1,600,000	1,300,000	300,000	1.2:1	27.5	22.	1.3:1
Sept. 24	Ontario fine sandy loam	7,000,000	4,600,000	2,400,000	1.5:1	30.	20.	1.5:1
Oct. 11	Dunkirk sandy loam	2,200,000	630,000	1,600,000	3.5:1	32.5	17.5	1.9:1
Oct. 20	Honeoye stony loam	8,000,000	5,000,000	3,000,000	1.6:1	30.8	19.5	1.6:1
Oct. 22	Dunkirk gravelly loam	13,500,000	3,500,000	10,000,000	3.8:1	46.	17.	2.7:1
Nov. 4	Dunkirk fine sand	2,800,000	2,800,000	0	1 :1	35.	33.8	1 :1
Nov. 4	Honeoye stony loam	6,000,000	6,300,000	—300,000	1 :1.05	21.5	25.	1 :1.2
Nov. 4	Dunkirk sandy loam	1,300,000	2,400,000	—1,100,000	1 :1.8	29.	36.5	1 :1.3
Nov. 4	Dunkirk gravelly loam	9,500,000	5,500,000	4,000,000	1.7:1	46.	18.5	2.5:1
1916								
Jan. 27	*Dunkirk fine sand	1,600,000	1,200,000	400,000	1.3:1	45.	30.	1.5:1
Jan. 28	*Honeoye stony loam	6,600,000	5,400,000	1,200,000	1.2:1	36.5	35.5	1 :1
Jan. 28	*Dunkirk sandy loam	1,800,000	1,600,000	200,000	1.1:1	60.	52.	1.2:1
Jan. 29	*Dunkirk gravelly loam	12,800,000	10,500,000	2,300,000	1.2:1	51.	26.5	1.9:1
	Average	6,500,000	3,520,000	2,980,000	2.15:1	37.5	20.5	2.1:1

* The last four pairs of analyses were made from the same samples as those on Nov. 4, 1915. During the intervening twelve weeks they had been kept in the laboratory. Meanwhile the Dunkirk fine sand and sandy loam had become almost completely dry. As these later analyses did not represent normal field conditions, their results are omitted from the averages in this table.

somewhat more striking. The average ratio, it is true (as shown in the last column of the table) was 2.1:1 or practically the same as the ratio between the actual numbers per gram; but there were only four cases that fell between the limits 1.2:1 and 1:1.2 and only two (May 21, 1914, and the third one listed on November 4, 1915) when the numbers in cultivated soil were enough greater than in sod to give a ratio outside these limits. These two cases both showed a ratio of 1:1.3 which is hardly to be compared with the maximum ratio, 7.2:1, in favor of sod soil.

The conclusion to be drawn from this comparison is that the few exceptional cases in which there were more Actinomycetes in the cultivated soil are completely overbalanced by the numerous cases in which there were more in the sod soil. In some of the borderline cases, the number of lower bacteria was greater in the cultivated soil than in the corresponding sod sample, with the result that the percentage of Actinomycetes was sometimes greater in the sod sample even though the actual number was the same in both samples.

The last four cases in the table are of special interest because they were analyses of the same samples collected on November 4, 1915, made after keeping the samples in the laboratory twelve weeks. On the date of collection the ratio obtained in the case of one pair of samples was in favor of the cultivated soil, while in two of the other cases it was nearly unity. At the time of the later analysis the ratios in these three cases were still all near unity, although none of them were actually in favor of cultivated soil.

TABLE III.—NUMBER OF ACTINOMYCETES IN THREE NEIGHBORING SPOTS OF A SINGLE SOIL TYPE: A COMPARISON OF OLD SOD, NEW SOD, AND CULTIVATED SOIL.

Numbers determined by means of gelatin plates.

Date.	Actual Number per Gram			Per Ct. of Total Flora.		
	Old sod.	New sod.	Cultivated.	Old sod.	New sod.	Cultivated.
May 29, 1914	8,000,000	....	*4,000,000	40.	....	*19
Sept. 1, 1914	12,000,000	....	*2,400,000	34.4	....	*14
Sept. 5, 1914	....	5,000,000	3,000,000	....	20.8	15.2
Sept. 10, 1914	8,500,000	7,500,000	2,500,000	47.2	21.7	13.8
Oct. 23, 1914	8,500,000	7,800,000	3,000,000	38.6	25.2	10.
Sept. 16, 1915	12,000,000	6,600,000	2,500,000	48.5	23.	12.5
Average	9,800,000	6,600,000	2,900,000	41.7	23.6	14.1

* The first two samples of cultivated soil were taken from a different spot from the rest, although similar in kind of soil and in state of cultivation.

The results of the other series of tests, comparing three neighboring spots in a single soil type, are given in Table III. The numbers obtained in this test were so constant that the few analyses mean as much as a longer series of irregular results. The average number of Actinomycetes in the old sod was 9,800,000 per gram, in the new sod 6,600,000 and in the cultivated soil, 2,900,000; or in percentages, they average 41.7 per ct., 23.6 per ct. and 14.1 per ct., respectively, of the total flora in these three spots. The lowest count (of Actinomycetes) in old sod was higher than the highest in new sod, and the lowest in new sod higher than the highest in cultivated soil. These figures indicate that the number of Actinomycetes in sod soil increases as the age of the sod grows greater.

The interpretation of the figures, however, hinges upon the question whether these organisms should be regarded as filamentous fungi producing spores or as unicellular bacteria occurring in filaments. On ordinary culture media they exist as branched filaments that break up under certain conditions into short rods or coccus-like bodies known as conidia because of their similarity to the conidia of molds in method of formation. When such cultures are plated, each colony ordinarily comes from one conidium or group of conidia. If they grow similarly in the soil and if the conidia are actually spores, an increase in the number of colonies on the plates may indicate merely an increase in spore-production. A few observations are at hand, however, to indicate that Actinomycetes occur in the soil not as filaments but as chains of short rods or cocci closely resembling ordinary bacteria. If this is the normal mode of growth in the soil and if these bodies are individuals instead of spores, an increase in the number of colonies on the plates may be regarded as more nearly representing a true increase in the number of the organisms in the soil.

Making the assumption that the latter condition actually exists in the soil, which seems justified so far as the facts are known, there are two explanations of the higher numbers observed in sod soil that seem likely enough to be considered. One is that sod soil becomes more compact in time than cultivated soil and that poor aeration favors the Actinomycetes in some way, in spite of the fact that they ordinarily seem to like a good supply of oxygen. This explanation does not well fit the facts, however; for it has been found that sod soil, dug up and well aerated and then kept in a pile for three months, may still retain its high Actinomyces content. The other explanation which has been considered is that the Antinomycetes are active in the decomposition of grass roots or perhaps of plant roots in general. In view of the past observations as to the association between Actinomycetes and plant roots, this explanation seems worth bearing in mind. Experiments are now being carried on which are designed to show whether or not this is the true function of Actinomycetes in soil.

THE NUMBER OF COLONIES ALLOWABLE ON SATISFACTORY AGAR PLATES.*

ROBERT S. BREED AND W. D. DOTTERRER.†

SUMMARY.

1. The work here reported includes a study of the counts made from 1435 agar plates inoculated from samples of market milk and incubated 5 days at 21° C.; and also a study of the counts made from 1056 of the same plates after 2 days additional incubation at 37° C. The results obtained indicate that, for milk analyses, the counts made from plates having more than 30 and less than 400 colonies on the plates are very nearly as satisfactory as those obtained from plates having more than 40 and less than 200 colonies, the latter being the limits in numbers originally recommended by the Committee on Standard Methods for the Bacterial Examination of Milk.

2. Plates having less than 20 or more than 400 colonies on them are shown to be so frequently widely discrepant that counts obtained from them should never be trusted unless checked by comparison with plates from different dilutions having more than 30 or less than 400 colonies. The acceptance of counts from plates having 20 to 30 colonies per plate would not increase the percentage of discrepancies greatly.

3. All groups of plates, regardless of the number of colonies on the plates, showed a certain percentage of plates which gave counts varying more than 20 per ct. from the accepted average. The percentage of discrepant counts of this sort varied between 37 and 7 for all groups of plates having more than 20 and less than 400 colonies per plate, the worst showing being made by the plates having 20 to 30 colonies per plate and the best by the plates having 100 to 200 colonies per plate.

4. The discrepancies which occurred in counts made from plates having less than 50 colonies per plate were more frequently caused by having too many colonies on the plates than by having too few colonies. This excess is undoubtedly due to the influence of chance air contaminations which took place during the plating. Where the plates have a small number of colonies on them a few extra colonies of this sort produce relatively wide discrepancies.

5. The discrepancies in counts made from plates having more than 50 colonies per plate were more frequently caused by having

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† The senior author of this paper is responsible for the original suggestion of this problem, for direction in carrying it out and aid in preparing the results for publication. The junior author has carried out the laboratory work and has helped in preparing the results for publication.

too few rather than too many colonies on the plates. The frequency of this type of discrepancy became very marked where the number of colonies exceeded 200 per plate. The probable explanation of the excess of this type of irregularity is that of overcrowding. Since, however, there was always a certain percentage of discrepancies caused by having too many colonies on the plate even where there were more than 400 colonies per plate, it is evident that not all of the irregularities are caused in this way.

6. Counts made from 20 duplicate samples of the same milk in five series of analyses showed 27 out of a possible 100 wide discrepancies in the counts obtained from an average of two plates made from a 1:1000 dilution. The number of colonies on these plates averaged more than 0.5 and less than 16.5 for the two plates, with one exception, where the average was 44. Counts made from the 100 pairs of 1:100 plates which had more than 24 and less than 125 colonies as the average of the 2 plates, showed only 4 out of a possible 100 wide discrepancies.

INTRODUCTION.

A point which is of importance in making bacteriological counts is the limit in the number of colonies that may be allowed to grow on a plate without introducing serious errors. Probably every bacteriological worker has this point in mind in making counts and has his own opinion based on experience; but there are few published data on the subject. One place where the matter has been under discussion is in connection with the proposed revision of standard methods of milk analysis. This investigation was made in order to increase the amount of information available for the use of the committees who have undertaken the work of revision.

HISTORICAL.

It is interesting to note the published opinions of different men on this point. In 1895 Neisser[1] published an article in which he reaches the conclusion that plates should be so made that they will have about 10,000 colonies per plate, which numbers should then be estimated by means of the low-power lenses of a compound microscope. He undoubtedly believed that each bacterial cell put into an agar plate would produce a colony regardless of overcrowding. Three years later Hesse and Niedner[2], realizing, to some extent at least, the true state of affairs, published an article in which they claim that plates having more than 100 colonies should be disregarded and that under these conditions the microscope should not be used for counting.

[1] Neisser, Max. Die mikroskopische Plattenzählung und ihre specielle Anwendung auf de Zählung von Wasserplatten. *Ztschr. Hyg. u. Infekt.* 20:119-146. 1895.

[2] Hesse, W., und Neidner. Die Methodik der bakteriologischen Wasseruntersuchung. *Ztschr. Hyg. u. Infeckt.* 29:454-462. 1898.

In 1897, Hill[3] contended that overcrowded plates would not give reliable results in water analysis. In 1899, Jordan and Irons[4] independently urged the same thing. Again in 1907 Hill[5] called attention to the point in a paper read before the laboratory section of the American Public Health Association in which he pointed out that wide discrepancies in counts might be caused by different methods of computation and concluded that only those plates having numbers of colonies falling between 40 and 200 per plate should be considered in reporting results. These figures were adopted in the report[6] presented by the Committee on Standard Methods for the Bacterial Examination of Milk at the Richmond meeting of the American Public Health Association. In the Report[7] presented at the Rochester meeting in September, 1915, the lower limit in the number of colonies allowable on agar plates was changed from 40 to 30, and the limits of 30 and 200 were also accepted by the Committee on Standard Methods of Bacterial Water Analysis in their Report[8] presented at the same meeting.

STATEMENT OF PROBLEM.

It is generally recognized that the kind of bacteria present in the material under examination will have an influence on the size of the colonies and, consequently, on the number that can develop on a plate. Some of the commonest and most important bacteria in milk do not produce colonies larger than pin points on ordinary agars even when only a few are present. Other colonies grow large and in the case of spreaders may cover the entire plate.

Just what prevents the development of all the bacteria into colonies on crowded plates is not thoroughly understood. In some cases it may be because the food material is all used up. In others it is clearly due to the fact that by-products of bacterial growth inhibit the growth of other colonies; and occasionally colonies fuse or overgrow each other and so reduce the count. On the other hand colonies growing side by side sometimes stimulate each other, a phenomenon which has been noted in this work on plates containing large numbers of *B. bulgaricus* with an occasional mold or bacterial colony of a different type. The molds and many bacteria so stimulate the *B. bulgaricus* that these organisms form visible colonies in the region of these larger colonies, failing to develop in all other parts of

[3] Hill, H. W., and Ellms, Joseph W. Report on Brooklyn Water Supply, pp. 164–169. 1897.

[4] Jordan, E. O., and Irons, E. E. Notes on Bacterial Water Analysis. Amer. Pub. Health Ass'n. *Public Health Papers and Reports* 25:564–569. 1899.

[5] Hill, H. W. The Mathematics of the Bacterial Count. *Amer. Jour. Pub. Hyg.* 18 (N. S. 4):300–310. 1908.

[6] Report of the Committee on Standard Methods of Bacterial Milk Analysis. *Amer. Jour. Pub. Hyg.* 20 (N. S 6):315–345. 1910.

[7] Report of the Committee on Standard Methods of Bacterial Examination of Milk. *Amer. Jour. Pub. Health.* 5:1261-1262. 1915.

[8] Not yet published.

the plate. A similar condition has been noted in plating material containing large numbers of long-chained streptococci. This phenomenon naturally produces marked irregularities in count when it occurs.

Because of these and other difficulties certain plates in any series made from a given sample are more satisfactory for use in computing a total count than are others. The matter of selecting plates to be used in computing a count therefore becomes a matter requiring considerable judgment.

EXPERIMENTAL DATA.

A. ANALYSES MADE IN THE STATION LABORATORY.

The object of this study has been to determine the limits in the number of colonies on plates which are satisfactory for making bacterial counts. The data used have been obtained by plating market milk samples on standard agar in triplicate and in three different dilutions, incubating for five days at 21°C. following with an incubation for two days at 37° C. The plates were counted at the end of five days and again after the two days incubation at 37° C. The five-day and seven-day counts are tabulated separately and show the conditions for each period of incubation.

In deciding which plate counts to select as probably nearest correct it became necessary to discard all of the counts on a few samples where no satisfactory average could be made because of spreaders or because the milk contained more bacteria than was anticipated, and the dilutions were not carried far enough to give assurance that the count was not affected by overcrowding. In selecting individual plate counts which were to be tabulated as satisfactory, those counts were chosen which could be used in making an average without any individual figure varying more than 20 per ct. from the average. All others are listed as discrepancies. For example, one sample gave the following counts per plate, 1:100 dilution 1944, 1472 and 1928 colonies; 1:1000 dilution 484, 515 and 610 colonies; 1:10,000 dilution 43, 45 and 46 colonies. The counts of 484 and 515 from the 1:1000 dilution were averaged with the 1:10,000 counts of 43, 45 and 46. This average was taken as the final count on the sample. The counts made on the 1:100 plates were all listed as discrepancies because they are more than 20 per ct. lower than the average, and the count of 610 from one of the 1:1000 plates was also listed as a discrepancy because it was more than 20 per ct. higher than the average. Occasionally all of the nine plates made from a sample could be included in the final average.

Table I gives the number of plate counts made after 5 days of incubation at 21° C., arranged in groups according to the number of colonies which appeared on the plates. Four hundred and thirty-nine of the 1435 plates had less than 10 colonies per plate. Only 22.3 per ct. of these checked within the 20 per ct. limit. One hundred

and eighty plates fell in the group having more than 10 and less than 20 colonies per plate. Of these 53.9 per ct. checked within the 20 per ct. limit. Percentages calculated for the groups of plates having 20 to 30, 30 to 50, 50 to 100, 100 to 200 and 200 to 400 colonies per plate were more or less variable, showing that from 66.3 per ct. to 93.2 per ct. of the total number of plates agreed within the 20 per ct. limit. The best percentage of agreement is shown by the group having more than 100 and less than 200 colonies per plate, and the

TABLE I.— PLATE COUNTS OF BACTERIA, GROUPED BY NUMBERS OF COLONIES PER PLATE.

Counts made after 5 days' incubation at 21° C.

GROUP.	CHECKED WITHIN 20 PER CT. OF AVERAGE.		DISCREPANT PLATES; DID NOT CHECK WITHIN 20 PER CT. OF AVERAGE.				Total number of plates in group.
	Number.	Per ct.	Too low.	Too high.	Total number.	Per ct.	
0 to 10	98	22.3	172	169	341	77.7	439
10 to 20	97	53.9	29	54	83	46.1	180
20 to 30	54	72.9	6	14	20	27.1	74
30 to 50	67	66.3	11	23	34	33.7	101
50 to 100	162	84.8	17	12	29	15.2	191
100 to 200	179	93.2	8	5	13	6.8	192
200 to 400	105	78.9	25	3	28	21.1	133
Over 400	100	44.4	114	11	125	55.6	225
0 to 30	249	35.9	207	237	444	64.1	693
20 to 400	567	82	67	57	124	18	691
30 to 400	513	83.1	61	43	104	16.9	617
20 to 200	470	82.9	43	54	97	17.1	567
30 to 200	416	84.3	37	40	77	15.7	493
40 to 200	376	86	23	28	61	14	437
Over 400	100	44.4	114	11	125	55.6	225

Total number of counts summarized in this table, 1435.

next highest by the group having between 50 and 100 colonies per plate. There were decidedly fewer plates giving satisfactory results among those which had more than 400 colonies per plate, the percentage of plates which checked within 20 per ct. being 44.4.

The results given in the lower part of Table I were calculated from the same counts, the groups of plates having been arranged differently. From this part of the table it will be seen that the percentage of discrepant plates is practically the same for the groups of plates having 20 to 400, 30 to 400, 20 to 200, 30 to 200, or 40 to 200 colonies per plate, the best showing being made by the group of plates having more than 40 and less than 200 colonies per plate. Plates having less than 30 colonies or more than 400 colonies show very large percentages of discrepancies.

Table II gives the results obtained by counting 1056 of the same plates as those whose counts are summarized in Table I after two days of additional incubation at 37° C. In general the results obtained from these counts are similar to those given in Table I. However, the best showings are made in this case by groups of plates having more than 200 and less than 400 colonies per plate (87 per ct. of satisfactory plates), the group of plates having 100 to 200 colonies (82.4 per ct.) and the group having 30 to 400 colonies per plate (81.4 per ct.). As in Table I there is a marked increase in the number of discrepant counts from plates having less than 30 or more than 400 colonies per plate. While the results in Table I favor the 40 to 200 group rather than the 30 to 400 group by 2.9 per ct., the same comparison in Table II shows an advantage of 1.6 per ct. for the 30 to 400 group. This indicates that there is little advantage in selecting one group of plates in preference to the other.

In the fourth and fifth columns of these two tables, the number of cases is shown in which the discrepancy was caused by having too few or too many colonies on the plate. Arranging the plates in the groups 0 to 10, 10 to 20, 20 to 30, 30 to 50, 50 to 100, 100 to 200, 200 to 400 and more than 400 colonies per plate, it is seen that there is a tendency for discrepancies caused by having too many colonies on a plate to occur in all groups having less than 50 colonies per plate (one exception to this statement is seen in the group 0 to 10 in Table I) In all cases where more than 50 colonies occurred on the plates, the greater number of discrepancies was caused by having too few colonies on the plates. The tendency toward discrepancies caused by having too few colonies on the plates becomes very marked as soon as the limit of 200 colonies per plate is passed.

These findings indicate that while the greater proportion of the discrepancies on plates having less than 50 colonies per plate are caused by the operations of the laws of choice and chance, yet there is some factor present which tends to cause more colonies to develop than should do so. In all probability this factor is chance contamination from the air which occurs during plating. As is well known,

it is common for supposedly sterile check plates to develop one, two or more colonies on prolonged incubation. The presence of these colonies on inoculated plates having fewer than 50 colonies per plate causes a relatively large error in the counts.

TABLE II.—PLATE COUNTS OF BACTERIA, GROUPED BY NUMBERS OF COLONIES PER PLATE.

Counts made after 5 days' incubation at 21° C. and 2 days' incubation at 37° C.

Group.	Checked within 20 per ct of Average.		Discrepant Plates; did not Check within 20 per ct. of Average.				Total number of plates in group.
	Number.	Per ct.	Too low.	Too high.	Total number.	Per ct.	
0 to 10	60	28.4	60	91	151	71.6	211
10 to 20	76	60	23	28	51	40	127
20 to 30	46	63	8	19	27	37	73
30 to 50	55	72.3	5	16	21	27.7	76
50 to 100	117	81	14	12	26	19	143
100 to 200	127	82.4	16	11	27	17.6	154
200 to 400	101	87	14	1	15	13	116
Over 400	78	50	74	4	78	50	156
0 to 30	182	44.2	91	138	229	55.8	411
20 to 400	445	79.2	57	61	117	20.8	562
30 to 400	399	81.4	49	42	91	18.6	490
20 to 200	353	77	45	60	105	23	458
30 to 200	307	79.7	37	41	78	20.3	385
40 to 200	277	79.8	36	34	70	20.2	347
Over 400	78	50	74	4	78	50	156

Total number of counts summarized in this table, 1056.

The tendency for irregularities due to having too few colonies on plates to occur in counts having 50 or more colonies per plate is too well known to all bacteriologists to require extended discussion. These are undoubtedly caused by the effect of overcrowding.

The fact that not all of the discrepancies on plates having more than 400 colonies per plate were of this sort is more significant, for it shows that not all of the discrepancies on plates having numerous colonies are due to overcrowding. Irregularities in the number of bacteria used in inoculating or chance contaminations are two things which might produce plates having too many colonies even on crowded plates.

When all of these things are taken into consideration, it becomes a difficult matter to decide upon the limits in number of colonies which should be allowed on plates. It is at once clear that plates having less than 20 and more than 400 colonies are so apt to be widely discrepant that counts from plates of this sort should be disregarded. There are likewise clear indications that plates having between 40 and 200 colonies per plate are as satisfactory as any that can be selected. However the results secured in this investigation do not indicate that serious errors would be introduced in routine work by extending these limits to 30 and 400, or even to 20 and 400, thereby lessening the amount of work necessary to secure acceptable counts.

B. NEW YORK CITY ANALYSES.

Another set of data which is more satisfactory in one way because of the fact that a very large number of plates were made from a single sample of milk, but which is also less satisfactory in another way because of the fact that it is more limited in its application, has been secured from a set of analyses made on November 19, 1915, by five New York State laboratories [9] under the supervision of Prof. H. W. Conn. In this series 20 samples of the same milk were sent to each laboratory for analyses. Four laboratories made plate counts,[10] one making them in duplicate so that five sets of plate counts are available. These were made from two dilutions of 1:100 and 1:1000 each. Two plates were made for each dilution. Three laboratories made microscopic counts, one making them in duplicate so that four sets of these counts are available.

The average of the accepted plate counts was 4250. The average of the microscope counts of clumps, or sources, was 5590. The close correspondence in results obtained by these two very different methods of counting makes it very probable that the total number of groups of bacteria in this milk was very close to 5,000 per cubic centimeter. The 1:100 dilution plates gave counts in which the average number of colonies on the two plates varied between 24 and 125. The 1:1000 plates gave counts in which the average number of colonies from the two plates varied between 0.5 and 16.5 with a single case where the average of the two plates was 44.

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[9] Lederle Laboratories, North's Sanitary Laboratories, N. Y. City Board of Health Laboratory, Borden's Laboratory, N. Y. Agric. Exp. Sta. Laboratory.

[10] Plates incubated for 48 hours at 37° C.

If we arbitrarily assume that plates giving a count more than 2500 above or below the average fail to check with the accepted count, we find that the averages of all but three of the 100 pairs of 1:100 plates check with the accepted count while there are 27 cases out of the 100 where the count from the 1:1000 dilution fails to check within these limits. It is important to note also that 23 of these 27 cases are instances where the discrepancy was such as to give a higher count than the accepted count, indicating that chance contaminations were probably the chief cause of trouble.

A COMPARISON BETWEEN AGAR AND GELATIN AS MEDIA FOR THE PLATE METHOD OF COUNTING BACTERIA.*

H. JOEL CONN AND W. D. DOTTERRER.

SUMMARY.

1. A comparison has been made between the counts obtained from 599 gelatin plates and 641 agar plates, inoculated with various samples of soil, in order to determine which medium was less likely to show plates giving widely discrepant counts. As each soil sample was plated in triplicate on each medium it was possible to measure the amount of divergence of each individual plate count from the average count of the sample from which it was made.

2. The results show that these discrepant counts are as likely to occur with one medium as with the other. Thirty-three per ct. of the agar plates and 33 per ct. of the gelatin plates gave counts which varied less than 5 per ct. from the average, while there were 24 per ct. of the plates of each medium that showed a divergence of over 15 per ct. from the average.

3. This surprising agreement between the two media indicates that the nature of the medium used has little or no influence in producing the occasional widely discrepant counts which occur. The cause of these must be sought for elsewhere, either in chance contaminations or more probably in irregularity of distribution of the bacteria in the material sampled.

DISCUSSION.

It is a well-known fact that gelatin was the first medium to be used in the poured-plate method of counting and cultivating bacteria. Later agar was introduced for the same purpose, and came into general favor among bacteriologists because of certain advantages it possessed over gelatin. These advantages are: that it will remain solid at temperatures so high as to melt gelatin; and that the organisms capable of liquefying agar are so very rare that plate cultures in ordinary work are never lost through liquefaction, as often occurs with gelatin.

There are, on the other hand, certain advantages of gelatin that have kept it from being entirely replaced by agar for use in plate cultures. Perhaps its most distinct advantage is the fact that the colonies produced upon it by different kinds of bacteria vary more in

* A reprint of part of Technical Bulletin No. 53, May, 1916.

appearance than those which they produce upon agar; a great advantage when qualitative work is to be done, although of no significance for routine quantitative bacterial analyses. Certain other advantages claimed for gelatin are as important in quantitative as in qualitative work. The first of these is that gelatin is free from the troublesome growths of organisms that spread over the surface of agar in such a way as to obliterate the count — which is generally admitted to be the greatest drawback of agar in ordinary routine analyses. It has also been claimed, although not so generally admitted, that in certain fields of investigation higher counts are obtained on gelatin than on agar. Lastly, it has been the impression in the minds of some workers that there is less variation between the counts obtained upon parallel plates with gelatin than with agar.

As there was room for doubt upon this last point, a summary of some of the work at this Station has been made in such a way as to throw light upon the question. The results summarized were all obtained in the course of an investigation of soil and the conclusions, therefore, are not of general appliction. Their chief interest lies in the fact that when the investigation was begun it was thought that agar was inferior to gelatin in all of the respects just mentioned. After some experimentation, however, an agar medium was found upon which the troublesome surface growths did not occur; and it was soon learned that by using a sufficiently long incubation as high a count of the bacteria in soil * could be obtained on this medium as on gelatin.

Even after a satisfactory agar medium had been obtained, the impression remained that parallel plates gave more consistent counts on gelatin than on agar. Data on this subject were at hand, as a long series of parallel counts had been made upon gelatin and upon agar, each sample having been plated in two dilutions with three or four plates of each medium in each dilution. The data were summarized to bring out the point in question. As it may be of interest to others working with similar media, this summary is now published.

The two media used were soil-extract gelatin and asparaginate agar.* At first glance it seems as if they differed too widely in composition to be compared; but it would be just as unfair to compare an agar and a gelatin medium to which exactly the same constituents had been added, because agar and gelatin themselves vary so greatly in composition and consistency that a formula giving very good results with one may give very poor results with the other. The comparison between the soil-extract gelatin and the asparaginate agar seemed as fair as possible, because both media gave equally satisfactory results in soil work, as shown in the publication just mentioned.

* Conn, H. Joel. Culture Media for Use in the Plate Method of Counting Soil Bacteria. N. Y. Agr. Exp. Sta., Tech. Bul. 38, 34 pp., 1914; *Centbl. Bakt.*, Abt. II; 44:719–734, 1915.

All of the plates included in this summary were incubated at a temperature of 18–19° C. Troublesome liquefaction of gelatin begins at this temperature in about one week, so seven days was chosen as the routine incubation time for gelatin. Agar, however, is not subject to liquefaction; and as it had been found that the colonies developed slowly on the agar medium used in this work, agar plates were incubated for fourteen days.

The method of summarizing the data used to bring out the point under investigation was to secure the average of all the individual plate counts obtained from a given sample in a single dilution, then to determine the variation of each individual count in this set from the average. The individual counts were then grouped according to the extent to which they varied from the average count of each set. Four groups were made, as follows:

1. Plate counts varying from 0 to 5 per ct. from the average.
2. Plate counts varying from 5.1 to 15 per ct. from the average.
3. Plate counts varying from 15.1 to 50 per ct. from the average.
4. Plate counts varying over 50 per ct. from the average.

Each set ordinarily consisted of three individual plate counts, but occasionally of as many as four. Sometimes one plate in a set gave an unreliable count, generally because of liquefaction in the case of gelatin or overgrowths in the case of agar; and in such cases the average count for the set had to be made from the two remaining plate counts. Ten sets of gelatin and one of agar had to be omitted entirely because not more than one plate in each had given a reliable count. The total number of gelatin plates included in the summary was 599, of agar plates 641. These figures show that liquefaction of gelatin proved more troublesome than overgrowths on agar.

Table 1 shows the number and percentage of the individual counts falling in each of the above groups.

Since the total number of gelatin plates used in the computation was not so large as the number of agar plates, it is more important to compare the percentages than the actual number of individual counts in each group. A glance at the table shows that the differences are too small to be of any significance. This is particularly true when the two dilutions are considered together. Of the gelatin plates 32.89 per ct. were within 5 per ct. or less of the average count, while 32.75 per ct. of the agar plates fell within this group. At the other extreme there were 0.5 per ct. of the gelatin plates showing over 50 per ct. variation and none of the agar plates in that group. This last difference is the greatest shown in any group, but is based upon too few instances to mean anything. In other words the count obtained on agar is just as consistent as that on gelatin.

These results do not necessarily mean that agar can replace gelatin entirely, even in the limited field investigated. Gelatin still remains more satisfactory as a basis of qualitative work; and even for

quantitative work the counts from agar were not as high as those from gelatin unless a longer incubation period was used. Nevertheless, the results show that there is no more irregularity between the counts obtained from parallel plates of asparaginate agar than from parallel plates of soil-extract gelatin, and also that the liquefaction of gelatin is a more troublesome feature than any of the difficulties — such as surface growths — that are peculiar to agar.

TABLE I.— NUMBER OF PARALLEL PLATE COUNTS ON AGAR AND GELATIN SHOWING DIFFERENT DEGREES OF VARIATION FROM THE AVERAGE.

VARIATION FROM THE AVERAGE COUNT			GROUP 1. 0 to 5 per ct.	GROUP 2. 5.1 to 15 per ct.	GROUP 3. 15.1 to 50 per ct.	GROUP 4. Over 50 per ct.
Dilution of 1 to 100,000	Number of plates in each group	Gelatin	108	110	63	1
		Agar	107	143	70	0
	Percentage in each group	Gelatin	38.3	39.0	22.3	0.4
		Agar	33.4	44.7	21.9	0.0
Dilution of 1 to 200,000	Number of plates in each group	Gelatin	89	147	79	2
		Agar	103	135	83	0
	Percentage in each group	Gelatin	28.1	46.3	24.9	0.7
		Agar	32.1	42.1	25.8	0.0
Both dilutions together	Number of plates in each group	Gelatin	197	257	142	3
		Agar	210	278	153	0
	Percentage in each group	Gelatin	32.89	42.90	23.71	0.5
		Agar	32.75	43.38	23.87	0.0

REPORT

OF THE

Department of Botany.

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TABLE OF CONTENTS.

I. Observations on some degenerate strains of potatoes.

II. Tree crickets as carriers of *Leptosphaeria coniothyrium* (Fckl.) Sacc. and other fungi.

III. Cork, drouth spot and related diseases of the apple.

IV. Lime-sulphur *vs.* bordeaux mixture as a spray for potatoes. IV.

[1] Absent on leave from September 30, 1915, to September 1, 1916.
[2] Appointed October 1, 1915; resigned August 31, 1916.

REPORT OF THE DEPARTMENT OF BOTANY.

OBSERVATIONS ON SOME DEGENERATE STRAINS OF POTATOES.*

F. C. STEWART.

SUMMARY.

This bulletin gives a detailed account of the behavior of a large number of potato plants of known parentage and belonging to degenerate strains of several different varieties.

The object of the study was to increase our knowledge of the diseases or forms of degeneration known as leaf-roll, curly-dwarf, mosaic and spindling-sprout and of their relation to the selection of seed potatoes.

A striking feature of the study was the frequency with which the progeny of plants having normal foliage and high yield suddenly degenerate into worthless dwarfs affected with leaf-roll, curly-dwarf, mosaic, spindling-sprout or other forms of degeneration.

The conclusion is reached that leaf-roll, curly-dwarf and mosaic are closely related disorders due to the same general, undetermined cause. In some respects they behave like bud-varieties; but they present, also, important points of difference. All are transmitted through the seed tubers. The progeny of affected plants almost invariably become affected.

The heredity of spindling-sprout is still undetermined and its cause is largely a matter of conjecture. However, it may be stated that spindling-sprout is not correlated with leaf-roll, mosaic or curly-dwarf.

There is no evidence that any one of the four forms of degeneration named is communicable from one plant to another except through the medium of the seed tubers. They are not due to any parasitic organism. Neither is unfavorable soil or weather conditions of the current season responsible.

In general, plants from different tubers of the same plant are similar; also, plants from different eyes of the same tuber usually resemble each other closely; but exceptions to both rules are frequent.

* A reprint of Bulletin No. 422, July, 1916.

Various combinations of normal, mosaic, leaf-roll and curly-dwarf plants may be obtained from the several tubers of one plant or even from the several eyes of one tuber.

The observations here recorded seem to warrant the following conclusions having a practical bearing on the selection of seed potatoes:

(1) Neither normal foliage nor high yield is a guaranty of productivity in the progeny of the following season. Degeneration may occur quite suddenly.

(2) It is unsafe to select seed potatoes from fields containing many degenerate plants. Even the normal plants from such fields are liable to produce worthless progeny.

(3) Mosaic threatens to become an important factor in the production of seed potatoes. It is transmitted through the seed.

(4) It is doubtful if any method of seed selection will prevent the "running out" of seed potatoes under certain conditions.

INTRODUCTION.

In the spring of 1914 the Horticultural Department of the Station undertook some potato-breeding experiments. The seed-stock used consisted of a few tubers of each of several varieties furnished by Prof. Wm. Stuart, of Washington, D. C. These tubers had been grown during the very dry season of 1913 at Honeoye Falls, N. Y., in experimental plats which the United States Department of Agriculture had at that place. They came from plants supposed to be healthy and were, mostly, of normal shape, fair size and good appearance. After notes had been made on each tuber as to its size, shape, weight and depth of the eyes all were planted in fertile clay loam soil about the middle of May. They were planted with much care by the tuber-unit system. To avoid error, the pieces of one tuber were all planted before another tuber was cut and wooden stakes were used to separate the tuber units. A single piece was planted in each hill. The distance between hills was twenty inches.

Early in July it became evident that many of the plants were decidedly abnormal. In every variety some of the plants were much smaller than normal; in fact, they were worthless dwarfs. The leaves were wrinkled and curled and yellowish green instead of dark green. On some of the affected plants the lower leaves

dropped prematurely and the upper leaves formed a compact, bushy head. The trouble was confidently diagnosed as curly-dwarf. The symptoms seemed to agree well with the description of curly-dwarf given by Mr. Orton in his Bulletin No. 64.*

It being plain that this lot of potatoes had no value for breeding experiments it was turned over to the writer for pathological study. The present paper deals chiefly with the behavior of these potato plants and their progeny in 1915, although it includes, also, observations on some other degenerate strains of potatoes. While the writer is unable to draw definite conclusions concerning the causes of the degeneration described it is believed that the observations are worthy of record.

OBSERVATIONS ON GREEN MOUNTAIN JR. IN 1914.

The variety Green Mountain Jr. appearing to be the most promising for such study was selected for special observation. Of this variety there were twenty-six plants from ten tubers. In the discussion which follows the original ten tubers will be designated by the capital letters A, B, C, etc., in the order in which they were planted. Tubers A, B, C, D, E and F were cut into three seed-pieces each; while tubers G, H, I and J, being smaller, were cut into two pieces each. The three plants produced by the three pieces of tuber A will be designated A_1, A_2 and A_3; those from tuber B, B_1, B_2 and B_3, etc.

All of the plants from tubers C, D, E and H, eleven in number, were very abnormal — small, yellowish, wrinkled and curled. All of the plants from the tubers A, B, F and G (also eleven in number) were of large size and, at the time, considered nearly or quite normal, although toward the end of the season many of the leaves rolled upward and turned brown around the margin. The contrast in appearance between these two lots of plants was very striking, the former being worthless dwarfs which died prematurely while the latter were large, thrifty and productive. The plants from tubers I and J were of special interest. The two plants from I were only about three-fourths normal size. The leaves were much curled and rolled (some upward, others downward) and severely browned on the margin. One of the two plants from J (J_1) closely

* Orton, W. A. Potato wilt, leaf-roll and related diseases. U. S. D. A. Bul. No. 64. 1914.

resembled those from I, while the other (J_2) was normal in size and appearance.

The average yield of the eleven "normal" plants from tubers A, B, F and G was 37.5 ounces; while that of the eleven very abnormal plants from tubers C, D, E and H was only 4.22 ounces. The tubers of the "normal" plants were of normal shape for the variety, namely, flat-oblong;* while those of the abnormal plants were nearly round.

TABLE I.— DATA PERTAINING TO TWENTY-SIX PLANTS OF GREEN MOUNTAIN JR. POTATOES GROWN IN 1914.

PLANT.	Size.	No. of tubers	Total weight[1]	Weight of largest tuber.	No. of tubers over 2 oz.	Shape of tubers.
			Oz.	Oz.		
A_1	Normal	8	42	11.5	5	Flat-oblong
A_2	"	10	39.5	6.5	7	" "
A_3	"	9	44.5	8	6	" "
B_1	"	6	33	11	5	" "
B_2	"	6	38.5	12.5	6	" "
B_3	"	6	48	12	6	" "
C_1	Dwarf	5	6	2	0	Nearly round
C_2	"	1	5.5	5.5	1	Flat-oblong
C_3	"	5	5.5	1.5	0	Nearly round
D_1	"	6	5.5	1.75	0	" "
D_2	"	8	3.5	.75	0	" "
D_3	"	5	4.5	1.5	0	" "
E_1	"	4	.75	.28	0	" "
E_2	"	3	1.25	.5	0	" "
E_3	"	2	1	.75	0	" "
F_1	Normal	8	38.5	9	6	Flat-oblong
F_2	"	7	29	6	6	" "
F_3	"	4	23.5	7	4	" "
G_1	"	9	28	7.5	5	" "
G_2	"	13	48	9.5	7	" "
H_1	Dwarf	7	6.5	2	0	Nearly round
H_2	"	5	7	2.5	1	" "
I_1	Medium	5	14.5	3.5	3	Much elongated
I_2	"	5	15.5	4	3	" "
J_1	"	6	23.5	4.5	5	" "
J_2	Normal	10	41.5	10	7	Flat-oblong

[1] It will be observed that the weights given in Table I do not agree exactly with those given in Table II. The difference is due, chiefly, to shrinkage during storage. The weights given in Table I were taken in the fall, while those in Table II were made the following spring.

* Stuart (U. S. D. A. Bul. No. 176:33) describes the shape of the tubers of Green Mountain Jr. as "round to oblong, somewhat flattened."

All of the ten tubers produced by the two plants from tuber I, on the contrary, were markedly elongated although the parent tuber had been nearly round.

Results still more surprising were obtained from J. One of the two plants, the one with abnormal foliage (J_1), produced six elongated tubers like those from I, while the other (J_2) gave ten tubers of the typical oblong shape. (Plates II and III.)

After the tubers had been washed, weighed and counted they were placed in paper bags (those of each plant in a separate bag) and stored in a cool cellar.

Table I shows for each of the twenty-six plants the number, shape and total weight of tubers, weight of the heaviest tuber and number of tubers weighing over two ounces.

OBSERVATIONS ON GREEN MOUNTAIN JR. IN 1915.

In the spring of 1915 the entire product of the twenty-six plants above described was planted with great care in such manner that the performance of each tuber could be followed.*

The tubers from each of the twenty-six plants were planted together in the order of their size from the smallest to the largest. Thus the plant A_1 having eight tubers (a, b, c, d, e, f, g and h weighing .32, 2, 2, 3.5, 6, 7, 8.5 and 11 ounces respectively) provided twenty-seven seed-pieces which, when planted, became plants A_1a, A_1b_1, A_1b_2, A_1c_1, A_1c_2, A_1d_1, A_1d_2, A_1d_3, A_1e_1, A_1e_2, A_1e_3, A_1f_1, A_1f_2, A_1f_3, A_1f , A_1g_1, A_1g_2, A_1g_3, A_1g_4, A_1g_5, A_1h_1, A_1h_2, A_1h_3, A_1h_4, A_1h_5, A_1h_6, and A_1h_7. Tuber a, being small, was planted whole. The others were cut into from two to seven pieces each according to their size. The pieces of each tuber were planted in the order in which they were arranged in the tuber; that is, the stem-end piece was planted first and the bud-end or " seed "-end piece last; while pieces from the middle portion of the tuber occupied a corresponding position in the order of planting. For example, plant A_1h_1 came from the stem-end piece of tuber h of hill A_1; plant A_1h_4 from a piece near the middle of the tuber; and plant A_1h_7 from the bud-end piece of the same tuber. This method was followed throughout the entire series. Tubers weighing less than about 1.5 ounces were

* Throughout these experiments the utmost care was taken to avoid errors. With the exception of the planting in 1914, all of the operations of planting, digging, washing, counting, weighing and note taking were done by the writer.

planted whole; larger ones were cut into pieces weighing from one to two ounces each. Table II gives the weight of each seed tuber and the number of seed-pieces into which it was cut.

TABLE II.— GREEN MOUNTAIN JR.: WEIGHT OF SEED-TUBERS AND NUMBER OF SEED-PIECES PER TUBER.

Plant (1914).	Tuber.	Weight.	Number of pieces.	Plant (1914).	Tuber.	Weight.	Number of pieces.	Plant (1914).	Tuber.	Weight.	Number of pieces.	Plant (1914).	Tuber.	Weight.	Number of pieces.
		Oz.				Oz.				Oz.				Oz.	
A_1...	a	.32	1	B_2..	f	12	6	E_2..	b	.5	1	G_2..	m	9	5
	b	2	2	B_3..	a	2.5	2		c	.5	1	H_1*.	a	.21	1
	c	2	2		b	5.5	3	E_3..	a	.38	1		b	.5	1
	d	3.5	3		c	7.5	5		b	.75	1		c	1	1
	e	6	3		d	8.5	6	F_1..	a	.18	1		d	1	1
	f	7	4		e	10	4		b	.75	1		e	1.5	1
	g	8.5	5		f	11.5	5		c	5	3		f	2	1
	h	11	7	C_1..	a	.18	1		d	5.5	4	H_2..	a	.31	1
A_2...	a	.28	1		b	1	1		e	5.5	4		b	1	1
	b	.28	1		c	1	1		f	5.5	4		c	1.5	1
	c	2	1		d	1.5	1		g	5.5	4		d	1.5	1
	d	3.5	2		e	2	1		h	8.5	5		e	2.5	1
	e	4.5	3	C_2..	a	5.5	4	F_2..	a	.45	1	I_1	a	1.5	2
	f	5	5	C_3..	a	.5	1		b	2.5	2		b	2	2
	g	5.5	4		b	.75	1		c	3	2		c	2.5	2
	h	5.5	4		c	1	1		d	5	4		d	2.5	3
	i	5.5	5		d	1.5	1		e	5	5		e	2.5	3
	j	6	5		e	1.5	1		f	5.5	4	I_2...	a	1.5	1
A_3...	a	.53	1	D_1*.	a	.35	1		g	6	4		b	2	1
	b	.63	1		b	.75	1	F_3..	a	4	2		c	3	2
	c	1.5	1		c	1	1		b	5.5	3		d	4	2
	d	5	4		d	1.5	1		c	6	3		e	4	2
	e	6	4		e	1.75	1		d	6.5	4	J_1...	a	1.5	1
	f	6.5	5	D_2*.	a	.18	1	G_1†.	a	.75	1		b	4	2
	g	7	6		b	.21	1		b	3.5	2		c	4.5	2
	h	7.5	5		c	.24	1		c	7.5	5		d	4.5	2
	i	8	5		d	.38	1	G_2..	a	.28	1		e	4.5	2
B_1...	a	.45	1		e	.75	1		b	.5	1		f	4.5	2
	b	2.5	2		f	.75	1		c	.75	1	J_2...	a	1	1
	c	4	3		g	.75	1		d	1.5	1		b	1	1
		4.5	4	D_3*.	a	.35	1		e	1.5	1		c	2	1
	e	9.5	5		b	1	1		f	2	1		d	2.5	1
	f	10.5	6		c	1.5	2		g	2.5	1		e	3	2
B_2...	a	2.5	2		d	1.5	2		h	4	2		f	3.5	2
	b	3	3	E_1*.	a	.14	1		i	5	3		g	4.5	2
	c	4	4		b	.24	1		j	5.5	3		h	5	3
	d	6	4		c	.28	1		k	6	4		i	5.5	3
	e	8.5	5	E_2..	a	.14	1		l	6.5	4		j	10	5

* One tuber rejected on account of very small s·ze.
† Six tubers of this hill rejected on account of a rot affecting the eyes.

GENERAL NOTES

After the plants came up the condition of each was noted, at intervals of a few days, on the following dates: June 14, 21, 28, July 5, 12 and 26.

June 14.— On June 14 all of the plants except three were up. They were two to five inches high.

In the majority of cases the plant from the stem-end piece was the smallest one of the tuber unit. Also, the plant from the bud-end piece was usually the largest. However, there were a number of exceptions. In several tuber units the plants were of uniform size. In a few, the plant from the stem-end piece was the largest and in a few others the bud-end piece produced the smallest plant in the unit. Also, there were instances in which a plant from the middle portion of the tuber was either the largest or the smallest plant in the unit.

Even at this early date it was apparent that many of the plants were abnormal. Their leaves were small, wrinkled, folded and curled; while those of normal plants were large, flat and spreading.

June 21.— Between June 14 and 21 there were two light showers. While the soil was dry on the surface it can scarcely have been possible that the plants suffered any from lack of water. The normal plants were nine to ten inches high. A considerable number of the abnormal plants now showed one to three of the lowermost leaves dying. In some cases these dying lower leaves had turned yellow and fallen. In others they were withered, but remained attached to the stem. None of the normal plants showed any tendency to drop their lower leaves. The abnormality of the abnormal plants had become considerably more marked and some plants which had appeared normal on June 14 were now clearly abnormal. Many of the abnormal plants were yellowish green while the normal plants were dark green.

June 28.— Following a heavy rain on June 22 the abnormal plants began to drop their lower leaves freely. The great majority dropped one to three leaves each. This gave them a trimmed-up appearance. (Plate VI.) None of the normal plants were dropping their leaves. For the most part, the contrast between normal and abnormal plants was striking. However, some plants were much more abnormal than others. Only a few appeared entirely normal. On these, all of the leaves, even the lowest, were of large size, dark green color and flat, spreading habit; while the leaves of abnormal plants were small, wrinkled, yellowish green and often curled or rolled. When normal and abnormal plants were seen together the difference in color was plain; but one seeing only the abnormal plants might not have detected anything abnormal in their color.

In different tuber-units the abnormal plants appeared differently.

There seemed to be at least two types — one in which the leaf-petioles were much shortened and the upper leaves much wrinkled, rolled or curled forming a dense, bushy head (Plate IV); and another in which the leaves, though smaller than normal, had their petioles only moderately shortened and the upper leaves only slightly wrinkled, rolled or curled. In both types some plants were dropping their lower leaves, but some of the worst cases of the bushy-head type were *not* dropping any leaves.

The plants of three tuber-units (A_2g, A_2h and A_2i) appeared different from all the rest. While decidedly smaller than normal they were holding all of their leaves which were neither wrinkled nor curled yet not flat. The leaves were partly folded and stood up instead of spreading out. The leaf-petioles were only slightly shortened. The color of the leaves was nearly normal.

July 5.— The plants were now of all sizes from five to twenty inches high and a motley lot. The stems of the larger plants, heretofore upright, were now lying on the ground. This was the result of recent heavy rains which had induced rapid growth and loosened the soil.

July 12.— Up to this time the writer had been much puzzled by the diverse appearance of the plants in different tuber-units. It was thought that most of them were affected with curly-dwarf to which disease the abnormalities appearing in the 1914 crop had been ascribed.

While inspecting some Long Island potato fields in company with Mr. W. A. Orton and others on July 7 and 8 we had learned from Mr. Orton to recognize the mosaic disease of potatoes.* It now became clear to us that many of our abnormal plants were affected with mosaic. Accordingly, in the observations of July 12, we were able (to some extent, at least) to distinguish between plants affected with curly-dwarf and those affected with mosaic. Also, at this time some of the plants began to show symptoms which we recognized as belonging to the leaf-roll disease.

July 26.— The changes taking place between July 12 and July 26 were chiefly along two lines: (1) The browning of the margins of the leaves of many plants, notwithstanding the presence of an abundance of moisture in the soil; (2) the appearance of leaf-roll symptoms in a considerable number of the plants.

* Described by Mr. Orton in U. S. Dept. Agr. Bul. 64:42.

Other notes.— After July 26 the abnormal plants declined rapidly and died. An attack of late blight in the latter part of August soon finished the normal plants so that all were dead by early September. Doubtless the yield of the normal plants was lowered somewhat by the attack of blight, but, fortunately, there was no loss from rot. The digging was done at various times between September 24 and October 9. The tubers from each plant were put into a separate paper bag and later washed, counted and weighed. The data thus obtained are shown in the accompanying Table III.

The plants did not suffer from lack of water at any time. Neither did they suffer from a superabundance of water. No sign of black-leg was observed and there were only traces of stem-end browning of the tubers or other symptoms indicating the presence of Fusarium or Verticillium wilt diseases. (See page 130.) None of the tubers showed any rot, discoloration (either internal or external) or blemishes of any kind which would account for the foliage symptoms. The manurial substances used consisted of a light application of stable manure and wood ashes thoroughly mixed with the soil before planting. No commercial fertilizer was used. The previous crop was potatoes which appeared entirely normal.

TABLE III.— DATA PERTAINING TO 360 HILLS OF GREEN MOUNTAIN JR. POTATOES GROWN IN 1915.

PLANT.	Disease.	Number of tubers.	Total weight.	Weight of largest tuber.	No. of tubers over 2 oz.	Shape of tubers.
			Oz.	Oz.		
A_1a....	Normal.......	3	9.25	6.25	2	Largest tuber narrowed at stem end.
A_1b_1...	Mosaic........	3	3.75	1.5	0	Normal — flat-oblong.
A_1b_2...	"	3	3	1.75	0	" "
A_1c_1...	"	6	4.75	1.25	0	" "
A_1c_2...	"	3	4.75	2	0	" "
A_1d_1...	"	5	4	1.75	0	" "
A_1d_2...	"	4	4	1.75	0	" "
A_1d_3...	"	6	4.75	1.5	0	" "
A_1e_1...	Curly-dwarf?...	6	2.25	.5	0	" "
A_1e_2...	" ...	2	2.5	2	0	" "
A_1e_3...	" ...	4	3.75	1.75	0	" "
A_1f_1....	Leaf-roll?......	7	14	3.75	3	Largest 3 narrowed at stem end.
A_1f_2....	"	9	13.25	3	4	Largest tuber narrowed at stem end.
A_1f_3....	"	7	6.5	1.75	0	Largest 3 narrowed at stem end.
A_1f_4....	"	4	5.5	2.75	1	Normal — flat-oblong.
A_1g_1...	Mosaic........	8	5.75	1.75	0	" "
A_1g_2...	"	4	6	2	0	Normal, or nearly so.
A_1g_3...	"	10	4.75	1	0	" "
A_1g_4...	"	8	4	1	0	" "
A_1g_5...	"	8	4.25	1	0	" "
A_1h_1...	"	2	6.75	4	2	Normal — flat-oblong.
A_1h_2...	"	5	9.5	4	2	Third largest narrowed at stem end.
A_1h_3...	"	4	5.5	1.5	0	Normal — flat-oblong.
A_1h_4...	"	6	7.25	1.75	0	" "

TABLE III (*continued*).

PLANT.	Disease.	Number of tubers.	Total weight.	Weight of largest tuber.	No. of tubers over 2 oz.	Shape of tubers.
			Oz.	*Oz.*		
A_1h_5...	Mosaic........	4	4.5	1.5	0	Normal — flat-oblong.
A_1h_6...	"	3	4	1.5	0	" "
A_1h_7...	"	7	3	.75	0	" "
A_2a....	Normal?......	*6	7.5	1.75	0	" "
A_2b....	Leaf-roll?......	1	1.75	1.75	0	" "
A_2c....	Mosaic........	12	7	1	0	" "
A_2d_1...	"	0	3.5	1	0	" "
A_2d_2...	"	6	4	1.25	0	" "
A_2e_1...	"	4	5	2.25	1	" "
A_2e_2...	"	8	4.25	1.25	0	" "
A_2e_3...	"	18	8.75	1.25	0	" "
A_2f_1....	"	3	2.5	1.25	0	" "
A_2f_2....	"	2	2.75	1.5	0	" "
A_2f_3....	"	4	2	1	0	" "
A_2f_4....	"	3	2.25	1.5	0	" "
A_2f_5....	"	5	2	.5	0	" "
A_2g_1...	Leaf-roll......	4	12.75	5	3	Largest 3 with narrowed bud end.
A_2g_2...	"	5	12.75	4.25	3	Largest 2 " " "
A_2g_3...	"	12	18	4	5	Largest 1 " " "
A_2g_4...	"	8	20.5	5	4	Largest 2 " " "
A_2h_1...	"	3	7.5	2.75	2	One tuber " " "
A_2h_2...	"	8	12	4	3	Largest 2 " " "
A_2h_3...	"	10	11	3.5	1	Largest 1 " " "
A_2h_4...	"	7	14.25	3.5	4	Largest 2 " " "
A_2i_1....	"	5	6	2.25	1	Normal — flat-oblong.
A_2i_2....	"	4	9	4.25	2	Largest 2 with narrowed bud end.
A_2i_3....	"	2	5	4	1	Normal — flat-oblong.
A_2i_4....	"	4	5	2.25	1	Largest slightly narrowed bud end.
A_2i_5....	"	4	12.5	6	3	Largest with narrowed bud end.
A_2j_1....	Mosaic........	4	2.75	1.25	0	Normal — flat-oblong.
A_2j_2....	"	2	2	1	0	" "
A_2j_3....	"	4	1.75	.75	0	" "
A_2j_4....	"	5	1.5	.5	0	" "
A_2j_5....	"	3	1.25	.5	0	" "
A_3a....	"	3	.5	.2	0	Normal.
A_3b....	"	3	1	.5	0	"
A_3c....	"	5	3	1	0	"
A_3d_1...	Leaf-roll......	5	6	2.25	1	"
A_3d_2...	"	4	7.25	4	1	"
A_3d_3...	"	5	6	2.25	1	"
A_3d_4...	Mosaic........	4	1.75	.5	0	"
A_3e_1...	Leaf-roll......	3	5.5	2.5	1	"
A_3e_2...	"	6	6	2.5	1	"
A_3e_3...	"	3	3.25	1.25	0	"
A_3e_4...	"	5	4	1.5	0	"
A_3f_1....	Curly-dwarf!...	4	.75	.25	0	"
A_3f_2....	" ...	2	.75	.5	0	"
A_3f_3....	" ...	4	1.25	.75	0	"
A_3f_4....	" ...	2	1	.5	0	"
A_3f_5....	" ...	7	1.25	.25	0	"
A_3g_1...	Mosaic........	5	1.75	.75	0	"
A_3g_2...	"	2	1.5	.75	0	"
A_3g_3...	"	4	1	.5	0	"
A_3g_4...	"	3	1.25	.5	0	"
A_3g_5...	"	0	.....	.....	....	"
A_3g_6...	"	7	1.5	.5	0	"
A_3h_1...	Curly-dwarf!...	2	1.5	1	0	"
A_3h_2...	" ...	5	1.25	.5	0	"
A_3h_3...	" ...	2	1.75	1.5	0	"
A_3h_4...	" ...	4	1.75	.75	0	"
A_3h_5...	" ...	4	1.5	.5	0	"
A_3i_1....	Mosaic?.......	5	5.25	2	0	"
A_3i_2....	"	4	4.75	1.75	0	"

*It is suspected that tubers of A_2a. A_2b, and A_2c were mixed at digging time.

TABLE III (*continued*).

PLANT.	Disease.	Number of tubers.	Total weight.	Weight of largest tuber.	No. of tubers over 2 oz.	Shape of tubers.
			Oz.	*Oz.*		
A_3i_3....	Mosaic?........	4	4.25	2	0	Normal.
A_3i_4....	Curly-dwarf...	2	2.75	2	0	"
A_3i_5....	" ...	6	3.5	1.25	0	"
B_1a....	Normal?.......	1	.5	.5	0	"
B_1b_1...	Curly-dwarf!...	5	2.25	1	0	"
B_1b_2...	" ...	5	2	1	0	"
B_1c_1...	" ...	2	2	1.25	0	"
B_1c_2...	" ...	3	2	.75	0	"
B_1c_3...	" ...	4	2.5	.75	0	"
B_1d_1...	" ...	4	1.75	.5	0	"
B_1d_2...	" ...	3	1	.75	0	"
B_1d_3...	" ...	3	.75	.5	0	"
B_1d_4...	" ...	4	1	.25	0	"
B_1e_1...	Leaf-roll!......	4	3.75	2	0	"
B_1e_2...	"	6	9.75	2.75	2	"
B_1e_3...	"	8	10	2.5	3	"
B_1e_4...	"	6	11.75	3.25	4	"
B_1e_5...	Curly-dwarf...	9	3	.75	0	"
B_1f_1....	Leaf-roll!......	3	3.5	1.5	0	"
B_1f_2....	"	4	8	2.75	2	"
B_1f_3....	Curly-dwarf!...	3	3	1	0	"
B_1f_4....	Leaf-roll!......	5	6	2	0	"
B_1f_5....	"	2	6.75	3.5	2	Largest tuber narrowed at bud end
B_1f_6....	"	8	6.25	2	0	Normal, or nearly so.
B_2a_1...	Mosaic!.......	6	4.25	1.25	0	Normal.
B_2a_2...	"	8	6.5	1.5	0	"
B_2b_1...	"	3	5.25	2.5	1	"
B_2b_2...	"	3	3.5	2	0	"
B_2b_3...	"	8	3.5	.75	0	"
B_2c_1...	"	10	4.5	1	0	"
B_2c_2...	"	2	4.25	2.25	1	"
B_2c_3...	"	5	5.5	1.75	0	"
B_2c_4...	"	6	5.25	1.5	0	"
B_2d_1...	Mosaic.......	11	13.5	2.5	2	"
B_2d_2...	{Mosaic / Leaf-roll}	6	9.25	2.25	1	"
B_2d_3...	Mosaic.......	7	7.75	2	0	"
B_2d_4...	"	10	10.75	3.5	1	"
B_2e_1 ...	"	6	8.25	4.25	1	"
B_2e_2...	"	9	6.25	1.5	0	"
B_2e_3...	"	3	7.5	3.5	2	"
B_2e_4...	"	8	7.5	2.5	1	"
B_2e_5...	"	8	8	1.5	0	"
B_2f_1....	"	6	8.75	2.5	2	"
B_2f_2....	"	8	9.5	1.75	0	Rounder than normal
B_2f_3....	"	8	7.25	2.25	1	Normal.
B_2f_4....	"	5	7.25	2.25	1	3 rounder than normal
B_2f_5....	"	6	8.75	2.25	1	Rounder than normal.
B_2f_6....	"	6	13	3.5	3	Normal.
B_3a_1...	Curly-dwarf!...	5	1.75	.75	0	"
B_3a_2...	" ...	4	1.5	.75	0	"
B_3b_1...	Mosaic!........	4	7.5	2.25	2	"
B_3b_2...	"	3	8	3	3	"
B_3b_3...	"	9	8.5	2	0	"
B_3c_1...	Curly-dwarf!...	1	1.75	1.75	0	"
B_3c_2...	" ...	2	2	1.75	0	"
B_3c_3...	" ...	3	2.5	1.25	0	"
B_3c_4...	" ...	4	3.25	1	0	"
B_3c_5...	" ...	5	3.5	1.25	0	"
B_3d_1...	" ...	Dug up and photographed (See Plate VI.)				
B_3d_2...	" ...	2	2.75	1.5	0	"
B_3d_3...	" ...	3	2.75	1.5	0	"
B_3d_4...	" ...	3	2.25	1.25	0	"
B_3d_5...	" ...	3	3	1.5	0	"
B_3d_6...	" ...	4	2.5	.75	0	"
B_3e_1...	Mosaic!.......	7	9.75	2.5	3	"

TABLE III (*continued*).

PLANT.	Disease.	Number of tubers.	Total weight.	Weight of largest tuber.	No. of tubers over 2 oz.	Shape of tubers.
			Oz.	Oz.		
B_3e_2....	Mosaic!	6	7	2.5	2	Normal.
B_3e_3....	"	7	8	1.5	0	"
B_3e_4....	"	10	12.75	3	1	"
B_3f_1....	"	10	13.25	2	3	"
B_3f_2....	"	5	9.5	2.5	4	"
B_3f_3....	"	4	9	3	3	"
B_3f_4....	"	10	11.5	2.5	3	"
B_3f_5....	"	12	9	1.75	0	"
C_1a....	Mosaic!	3	1.25	.5	0	"
C_1b....	"	2	6	3	2	"
C_1c....	"	11	5.5	1.25	0	"
C_1d....	"	2	5.25	3.5	1	"
C_1e....	"	6	8	2	0	"
C_2a_1....	Curly-dwarf!	2	1	.5	0	"
C_2a_2....	"	3	2	1.25	0	"
C_2a_3....	"	5	2.25	.5	0	"
C_2a_4....	"	5	1.75	.5	0	"
C_3a....	Mosaic!	2	2.25	1.5	0	"
C_3b....	"	6	3.75	.75	0	"
C_3c....	"	8	4.5	1.25	0	"
C_3d....	Mosaic!	5	4.5	1.5	0	Normal.
C_3e....	"	5	5.25	1.5	0	"
D_1a....	"	4	2.75	1	0	"
D_1b....	"	3	4.75	2.5	1	"
D_1c....	"	5	6.25	2.5	1	"
D_1e....	"	12	6.5	1.25	0	"
D_1f....	"	8	6	1	0	"
D_2a....	"	2	1.25	1	0	"
D_2b....	"	3	1.75	.75	0	"
D_2c....	"	3	1.5	.75	0	"
D_2d....	"	7	2.5	.5	0	"
D_2e....	"	8	4.25	1.25	0	"
D_2f....	"	5	4.25	1.25	0	"
D_2g....	"	4	3.5	1.25	0	"
D_3a....	Mosaic?	2	.12	.09	0	Too small to determine.
D_3b....	"	1	.25	.25	0	" " "
D_3c_1....	"	3	.25	.12	0	" " "
D_3c_2....	"	2	.25	.12	0	" " "
D_3d_1....	"	3	.25	.14	0	" " "
D_3d_2....	"	3	.25	.12	0	" " "
E_1a....	Mosaic	1	.07	.07	0	" " "
E_1b....	"	2	.17	.12	0	" " "
E_1c....	"	2	.17	.12	0	" " "
E_2a....	"	1	.07	.07	0	" " "
E_2b....	"	2	.25	.14	0	" " "
E_2c....	"	2	.25	.14	0	" " "
E_3a....	"	2	.25	.14	0	" " "
E_3b....	"	3	.42	.17	0	" " "
F_1a....	?	0	.....	.....	....	
F_1b....	Leaf-roll	8	15	*3.25	4	Normal.
F_1c_1....	Mosaic	11	2	.5	0	"
F_1c_2....	?	9	12	3.5	2	"
F_1c_3....	Mosaic	8	2.25	.5	0	"
F_1d_1....	Mosaic!	4	6	2	0	"
F_1d_2....	"	4	6	2.25	1	"
F_1d_3....	"	5	6	1.75	0	"
F_1d_4....	"	4	6.5	2	0	"
F_1e_1....	Leaf-roll	10	21	4.25	6	"
F_1e_2....	Normal	7	26	4.75	6	"
F_1e_3....	Mosaic	6	7.5	2.25	1	"
F_1e_4....	"	10	6.75	1.25	0	"
F_1f_1....	Leaf-roll	14	27.5	4.25	5	"
F_1f_2....	Normal	8	22	6.25	6	"

* This tuber may have come from F_1a.

TABLE III (*continued*).

PLANT.	Disease.	Number of tubers.	Total weight.	Weight of largest tuber.	No. of tubers over 2 oz.	Shape of tubers.
			Oz.	*Oz.*		
F_1f_3....	Normal?........	9	17.25	3	4	Normal.
F_1f_4....	Normal........	8	25.5	5.25	6	"
F_1g_1...	"	8	23.25	7	4	"
F_1g_2...	"	10	18.5	4.5	5	"
F_1g_3...	"	7	17.75	4.25	6	"
F_1g_4...	"	15	27.25	5.5	7	"
F_1h_1...	Mosaic!.......	4	3	1.5	0	"
F_1h_2...	"	5	5.5	3.25	1	"
F_1h_3...	"	5	1.25	.5	0	"
F_1h_4...	"	7	5.75	2	0	"
F_1h_5...	"	7	1.75	.75	0	"
F_2a....	Mosaic........	3	2.25	1.25	0	"
F_2b_1...	"	9	5.25	1	0	"
F_2b_2...	"	6	5.25	1.5	0	"
F_2c_1...	"	5	4.75	1.5	0	"
F_2c_2...	"	5	4	1.5	0	"
F_2d_1...	"	6	5	2.25	1	"
F_2d_2...	"	3	5	2.5	1	"
F_2d_3...	"	5	6	3.25	1	"
F_2d_4...	"	6	7.5	3	1	"
F_2e_1....	"	4	4	1.5	0	"
F_2e_2....	"	2	3	2.5	1	"
F_2e_3....	"	2	2.75	1.5	0	"
F_2e_4....	"	4	3.5	1.5	0	"
F_2e_5....	"	5	4.25	1.5	0	"
F_2f_1....	?	3	4.5	2	0	"
F_2f_2....	?	4	7.5	3	2	"
F_2f_3....	?	4	7.25	2.5	2	"
F_2f_4....	?	3	7	3.5	1	"
F_2g_1...	Mosaic!.......	2	4.5	2.5	1	"
F_2g_2...	"	4	4	2	0	"
F_2g_3...	"	4	3	1.5	0	"
F_2g_4...	"	4	4	1.25	0	"
F_3a_1...	Mosaic........	3	3.5	1.25	0	"
F_3a_2...	"	5	4.25	1.25	0	"
F_3b_1...	"	2	3.75	2.75	1	"
F_3b_2...	"	4	3.5	1.25	0	"
F_3b_3...	"	5	3	1	0	"
F_3c_1...	"	1	3.5	3.25	1	"
F_3c_2...	"	3	4	2	0	"
F_3c_3...	"	8	4	.75	0	"
F_3d_1...	"	5	3.75	1.75	0	"
F_3d_2...	"	1	2	2	0	"
F_3d_3...	"	4	3.25	1	0	"
F_3d_4...	"	6	2.5	.5	0	"
G_1a....	Leaf-roll.......	13	12.5	2.5	2	"
G_1b_1...	Mosaic!.......	8	4.25	.75	0	"
G_1b_2...	"	6	9.5	2	0	"
G_1c_1...	"	7	6.25	1.5	0	"
G_1c_2...	"	9	7.25	2	0	"
G_1c_3...	"	8	5.5	1.5	0	"
G_1c_4...	"	3	5	1.75	0	"
G_1c5...	"	7	7.5	1.5	0	"
G_2a....	Leaf-roll?.......	5	3.5	1	0	"
G_2b....	Mosaic........	2	1.5	1	0	"
G_2c....	?	3	2.5	1	0	"
G_2d....	Leaf-roll.......	3	6.5	2.5	1	"
G_2e....	"	9	12	2.25	1	"
G_2f....	Mosaic!.......	7	5	1.5	0	"
G_2g....	"	9	4	1	0	"
G_2h_1...	Leaf-roll?......	8	11.5	3.5	2	"
G_2h_2...	Mosaic........	9	9	1.5	0	"
G_2i_1....	?	4	8.5	3.75	2	"
G_2i_2....	?	7	9.5	2	0	"
G_2i_3....	?	6	12	3.5	3	"
G_2j_1....	Leaf-roll!......	5	7.5	2.5	2	Much elongated.

TABLE III (*continued*).

PLANT.	Disease.	Number of tubers.	Total weight.	Weight of largest tuber.	No. of tubers over 2 oz.	Shape of tubers.
			Oz.	Oz.		
G_2j_2....	Leaf-roll!......	5	18	4.5	5	Normal.
G_2j_3....	"	7	14	2.5	2	Much elongated.
G_2k_1...	"	6	18	4	5	Normal.
G_2k_2...	"	6	13	5.25	3	"
G_2k_3...	"	5	11	3.5	4	"
G_2k_4...	Leaf-roll!......	10	15	3.5	5	"
G_2l_1....	"	7	11.5	4.5	2	"
G_2l_2....	"	7	9.5	2.5	2	"
G_2l_3....	"	5	7	2.5	1	"
G_2l_4....	"	7	6	1.75	0	"
G_2m_1...	"	10	17	3	6	"
G_2m_2...	"	7	15	5.5	4	"
G_2m_3...	"	6	16.5	5	3	"
G_2m_4...	"	10	14	3	3	"
G_2m_5...	"	12	15	4.25	3	"
H_1a....	Mosaic!.......	4	2.5	.75	0	"
H_1b....	"	6	5	1.5	0	"
H_1c....	"	7	8	2	1	"
H_1d....	"	6	7	2	0	"
H_1e....	"	6	8.5	2	1	"
H_1f....	"	7	10	2.25	3	"
H_2a....	"	4	2.5	1	0	"
H_2b....	"	4	6.25	2.25	2	"
H_2c....	"	7	6.5	1.5	0	"
H_2d....	"	4	8	2	0	"
H_2e....	"	8	8	2.5	1	"
I_1a_1....	Leaf-roll?......	*3	7	3	2	Much elongated.
I_1a_2....	Leaf-roll.......	5	7	1.75	0	" "
I_1b_1....	Leaf-roll?......	3	9	3.5	3	" "
I_1b_2....	Mosaic!.......	6	2.5	.75	0	Not elongated.
I_1c_1....	Mosaic........	8	4.25	1.5	0	Larger tubers elongated.
I_1c_2....	Mosaic!.......	3	2	.75	0	Somewhat elongated.
I_1d_1....	"	5	1.75	.5	0	Not elongated.
I_1d_2....	"	5	2	.75	0	One slightly elongated.
I_1d_3....	"	4	2	.75	0	Somewhat elongated.
I_1e_1....	Mosaic........	4	4	2.5	1	Distinctly elongated.
I_1e_2....	Leaf-roll?......	6	5.25	2.75	1	Much elongated.
I_1e_3....	"	7	13.5	3.5	4	" "
I_2a....	Leaf-roll!......	15	11.5	2.5	1	" "
I_2b....	Mosaic!.......	5	2	.5	0	Not elongated.
I_2c_1....	Leaf-roll!......	9	8.5	1.5	0	Distinctly elongated.
I_2c_2....	"	7	16	4.25	4	Much elongated.
I_2d_1....	Mosaic!.......	5	2	.5	0	Not elongated.
I_2d_2....	"	5	2.25	1	0	Larger ones elongated.
I_2e_1....	Leaf-roll?......	9	13	2.5	4	Much elongated.
I_2e_2....	"	8	22	4	6	" "
J_1a....	Mosaic!.......	3	1.75	.75	0	Not elongated.
J_1b_1....	"	†8	2.5	.5	0	" "
J_1b_2....	"	7	2.25	.5	0	" "
J_1c_1....	"	4	2	1	0	" "
J_1c_2....	"	9	4	.5	0	" "
J_1d_1....	"	6	1.5	.5	0	" "
J_1d_2....	"	7	2.5	1	0	Largest slightly elongated.
J_1e_1....	"	3	2	.75	0	Not elongated.
J_1e_2....	"	7	3	.75	0	" "
J_1f_1....	Normal?.......	7	14.5	4.5	4	Much elongated.
J_1f_2....	Mosaic........	8	4.5	.5	0	Not elongated.
J_2a....	Normal.......	14	30.5	6	6	Normal.
J_2b....	Mosaic........	3	2	.75	0	Not elongated.
J_2c....	"	3	4	1.75	0	" "
J_2d....	"	14	3.5	.5	0	" "
J_2e_1....	"	3	3	1.25	0	" "

* One tuber may belong to I_1a_2.
† J_1b_1 and J_1b_2 were accidentally mixed in digging.

TABLE III (*concluded*).

PLANT.	Disease.	Number of tubers.	Total weight.	Weight of largest tuber.	No. of tubers over 2 oz.	Shape of tubers.
			Oz.	Oz.		
J_2e_2....	Mosaic........	7	4.25	1	0	Not elongated.
J_2f_1....	"	6	2.5	1.25	0	" "
J_2f_2....	"	4	2.5	.75	0	" "
J_2g_1....	"	8	3.5	.75	0	" "
J_2g_2....	"	10	2.75	.5	0	" "
J_2h_1....	"	2	3	1.75	0	" "
J_2h_2....	"	4	4.5	1.75	0	" "
J_2h_3....	"	7	4.5	1.25	0	" "
J_2i_1....	"	4	4.5	2.25	1	" "
J_2i_2....	"	3	2.5	1	0	" "
J_2i_3....	"	8	4.25	.75	0	" "
J_2j_1....	"	3	3	1.5	0	" "
J_2j_2....	"	7	4.5	1.5	0	" "
J_2j_3....	"	7	3	1	0	" "
J_2j_4....	"	3	3	1.75	0	" "
J_2j_5....	"	10	4.25	.75	0	" "

DISCUSSION OF TABLE III.

A very little study of Table III is sufficient to convince one that this lot of 360 potato plants was very interesting. Many important data it was not possible to show in the table. Perhaps the best way to present these data is to take up each of the plants grown in 1914 and follow out the performance of its progeny in 1915. In doing this it will be necessary to refer frequently to Tables I and II as well as to Table III.

Progeny of A_1.—This plant was thought to be normal or nearly so. It yielded eight tubers of normal shape and having a total weight of 42 ounces. In 1915 it made 27 plants—A_1a to A_1h_7 in Table III. Although planted in fertile soil and given the best of care and cultivation 14 ounces was the largest yield of any of the 27 plants and only 14 tubers weighed more than two ounces. The average yield was 5.6 ounces per plant. A_1a, from the smallest tuber, was the only plant in which the foliage appeared normal up to July 26. All others were affected with mosaic, curly-dwarf or leaf-roll. However, the yield of A_1a was smaller than that of three other plants. Although the foliage was entirely normal the plant was small, owing, probably, to the very small size (.32 oz.) of the parent tuber.

Plants A_1b_1 to A_1d_3 were all clearly and severely affected with mosaic. The leaves were much wrinkled, somewhat curled and

yellowish green. The lower leaves dropped early. The plants were not bushy-headed.

Plants A_1e_1 to A_1e_3 differed from those last mentioned in having dense, bushy heads of curled leaves. In Table III the disease affecting these plants has been given as curly-dwarf, but it may have been mosaic. According to Orton, plants affected with curly-dwarf are of normal color whereas these were yellowish green.

Up to June 21 plants A_1f_1 to A_1f_4 appeared normal. The leaves were large, flat and dark green. But by June 28 the young upper leaves were folded and as they grew in size they rolled from the margin inward and upward. It is believed that they had a mild attack of leaf-roll. Certainly, they were not affected with mosaic. In three of the four hills of this tuber-unit the larger tubers were somewhat narrowed at the stem end, though the parent tuber had shown no such tendency.

Plants A_1g_1 to A_1h_7 were all undoubtedly affected with mosaic.

Progeny of A_2.—Plant A_2 appeared nearly or quite normal in 1914. It yielded ten tubers having a total weight of 39.5 ounces. All were of normal shape—flat-oblong. When planted in 1915 they made 31 plants—A_2a to A_2j_5 in Table III.

Tubers a and b were very small, weighing only .28 of an ounce each. As was to be expected, both made small plants. A_2b, which did not appear above ground until June 28, ultimately showed symptoms of leaf-roll and amounted to nothing. A_2a, though quite small, appeared normal until about July 26 when it showed wrinkled leaves on one shoot.

A_2c to A_2f_5 were quite similar and all severely affected with mosaic. They were yellowish green and dropped their lower leaves early. The average yield of this group was four ounces per plant.

A_2g_1 to A_2i_5 constitute another group of similar plants quite different from the last-mentioned group. The casual observer, without normal plants for comparison, might have pronounced them normal except in size. They were distinctly undersized. However, they showed symptoms of leaf-roll and were undoubtedly affected with that disease. It is equally certain that they were not affected with mosaic. They were of dark green color and held their lower leaves. The average yield of this group was 11.25 ounces per plant. An outstanding feature of the group was the shape of the tubers. On eleven of the thirteen plants some of the tubers were much

narrowed at the bud end, and it was invariably the larger tubers which were so affected. (Plate X, fig. 2.) In each case the shape of the parent tuber had been flat-oblong.

A_2j_1 to A_2j_5, although from a tuber weighing six ounces, the largest in the hill, were so small as to be absolutely worthless. Their average yield was only 1.85 ounces per plant. They were severely affected with mosaic and showed no tendency to form heads.

Progeny of A_3.—Plant A_3 appeared normal and gave the large yield of 44.5 ounces. It yielded nine tubers which furnished 32 seed-pieces for planting in 1915. Every one of the 32 plants produced (A_3a to A_3i_5) was badly diseased. Some were affected with mosaic, some with curly-dwarf and some with leaf-roll. The largest yield of any plant was 7.5 ounces and the average yield was only 2.64 ounces per plant.

The tuber unit d is of especial interest. Three pieces of tuber d produced plants (A_3d_1, A_3d_2 and A_3d_3) which became affected with leaf-roll without showing any symptoms of mosaic; while the fourth piece (bud-end) produced a plant (A_3d_4) affected with mosaic without any symptoms of leaf-roll. The three plants affected with leaf-roll held their lower leaves, but the plant affected with mosaic dropped its lower leaves and presented the characteristic trimmed-up appearance.

Progeny of B_1.—In 1914 B_1 produced six tubers having a total weight of 33 ounces. The plant was large and supposed to be normal. It provided seed for 21 plants in 1915. B_1a, though a very small plant, had foliage which was nearly or quite normal. All others were plainly diseased. The plants from tubers b, c, and d were bushy-headed curly-dwarfs. Four plants from tuber e were much affected with leaf-roll and showed, also, traces of mosaic; while the fifth (from the bud-end piece) was affected with curly-dwarf. A piece from near the middle of tuber f produced a plant (B_1f_3) affected with curly-dwarf; while pieces from both ends of the tuber produced plants affected with leaf-roll.

Progeny of B_2.—In 1914 B_2, apparently normal, produced six tubers having a total weight of 38.5 ounces. It provided seed for 24 plants in 1915. All were affected with mosaic. B_2d_1 had four stalks two of which were normal and the other two severely affected with mosaic. The normal stalks held their leaves clear to the ground, but the stalks affected with mosaic were trimmed

up in the usual manner. B_2d_2 had three stalks—one showing mosaic, one having pronounced leaf-roll and one which was normal.

Progeny of B_3.—Plant B_3 yielded six tubers weighing 48 ounces which is at the rate of 435 bushels per acre. It seems as if this plant must have been normal and, as a matter of fact, the foliage appeared normal. Nevertheless, every one of the 25 plants grown from tubers of this plant in 1915 was diseased. Some were affected with mosaic, others with curly-dwarf. The average yield was 5.7 ounces per plant.

Progeny of C_1.—In 1914 C_1 was badly dwarfed and diseased. It was thought to be affected with curly-dwarf, but may have had mosaic instead. It yielded five tubers the combined weight of which was only six ounces. Being so small, the tubers were planted whole in 1915. The five plants which they produced (C_1a to C_1e) were clearly and severely affected with mosaic. They were very small and cast their lower leaves in the latter part of June. The remaining leaves were small, wrinkled and yellowish green, but did not form bushy heads. The average yield was 5.1 ounces per plant. The tubers were of normal shape.

Progeny of C_2.—Plant C_2 was similar to C_1 so far as the parts above ground were concerned, but the crop consisted of a single tuber weighing 5.5 ounces. At planting time in 1915 this was cut into four pieces from which came plants C_2a_1 to C_2a_4. These four plants were all exactly alike. They were pronounced curly-dwarfs of very small stature. The lower leaves dropped in June. Those remaining were small, wrinkled and curled and formed dense, bushy heads at the summit of the stalks. The color of the leaves was nearly or quite normal. The average yield was 1.7 ounces per plant.

Progeny of C_3.—This plant closely resembled C_1 in all respects. In 1915 its five tubers were planted whole. They became affected with mosaic exactly like the progeny of C_1. The average yield per plant was four ounces.

Progeny of D_1, D_2, and D_3. These three plants were quite similar in all respects to C_1 and C_3. They were very badly diseased—whether with mosaic or curly-dwarf is not known with certainty. In Table I they are credited with a total of 19 tubers, but three were too small to plant. From the remaining 16 tubers 18 plants were obtained in 1915. All became so severely affected with mosaic as to be practically worthless. The 18 plants produced only two

tubers of marketable size. The average yield was 2.6 ounces per plant.

Progeny of E_1, E_2 and E_3.—These, also, were worthless dwarfs in 1914. They attained a height of only six inches. The lower leaves dropped very early leaving only a tuft of downward-curled, brown-margined leaves at the summit of each of the stalks. The total yield of the three plants was nine very small tubers having a combined weight of three ounces. Only eight of the tubers were planted in 1915. The plants which they produced (E_1a to E_3b) were all affected with mosaic and smaller and more worthless even than their parents. The most productive of the eight gave a yield of less than one-half ounce.

Progeny of F_1.—Coming to the F unit of 1914 we have plants similar to those of the A and B units except that they were somewhat smaller and gave a smaller yield. Their foliage was considered to be nearly or quite normal. F_1 was the largest and gave the largest yield — 38.5 ounces. In 1915 this plant furnished seed for 26 plants; namely F_1a to F_1h_5. Owing to the very small weight (.18 oz.) of seed-tuber little was to be expected of F_1a. It was extremely small and died early without producing tubers. F_1b (from the next largest tuber, weighing .75 oz.) appeared entirely normal until after July 12. The leaves were large, flat, spreading and dark green. However, by July 26 plain symptoms of leaf-roll were showing. The upper leaves were rolling from the margins inward and upward. This plant yielded 15 ounces of tubers.

The three plants from tuber c (F_1c_1, F_1c_2 and F_1c_3) appeared normal up to June 28. On July 5 F_1c_2 was still normal with broad, flat, spreading leaves showing no inclination to drop. But F_1c_1 and F_1c_3 were considerably smaller, the lower leaves had fallen and those remaining were small and wrinkled. Both were bad cases of mosaic. By July 12 F_1c_2 began to show traces of some unrecognized trouble. The leaves on one side of one stalk were dead. However, there were no symptoms of mosaic, curly-dwarf or leaf-roll. The difference in the yield of these three plants corresponded with the difference in their appearance. The yield of F_1c_1 was 2 ounces; of F_1c_2 12 ounces; and of F_1c_3 2.25 ounces.

The four plants from tuber d (F_1d_1 to F_1d_4) were all severely affected with mosaic. They were all alike and yielded about six ounces each.

Tuber e gave one plant showing plain symptoms of leaf-roll in one stalk, two plants severely affected with mosaic and one plant which appeared normal throughout the season. The leaf-roll plant (F_1e_1) yielded 21 ounces; one mosaic six ounces and the other 6.75 ounces; while the normal plant (F_1e_2) yielded 26 ounces.

Tuber f produced four plants which appeared normal up to July 12, but by July 26 some leaves on two stalks of F_1f_1 were showing leaf-roll and the foliage of F_1f_3 was turning yellow and brown from some unknown cause. The other two plants continued normal. The yield of all four was fairly good.

The tuber-unit consisting of the four plants from tuber g (F_1g_1 to F_1g_4) enjoys the distinction of being the only unit in the entire experiment in which all of the plants continued normal to the end of the season. However, the average yield of the plants in this unit was somewhat less than in the preceding unit.

Tuber h, weighing 8.5 ounces and the largest in the hill, produced five badly diseased (mosaic) plants which gave an average yield of only 3.45 ounces.

Progeny of F_2.—The seven tubers of this plant made 22 plants in 1915; namely, F_2a to F_2g_4. With the exception of the four plants from tuber f all were severely affected with mosaic. The leaves were small, wrinkled and curled downward. The lower leaves fell prematurely and those remaining formed bushy heads. The highest yield was 7.5 ounces.

The plants of the f unit differed from the others by holding all of their leaves and by having some leaves rolled upward on the margins. They were very abnormal, but it was not clear what ailed them. They presented symptoms of three diseases — mosaic, curly-dwarf and leaf-roll.

Progeny of F_3.—F_3 made 12 plants — F_3a to F_3d_4. All became severely affected with mosaic and were strikingly similar. The leaves were small, wrinkled, curled, yellowish green and formed bushy heads. The lower leaves dropped in June. The plants were dwarfs. The highest yield of any hill was 4.25 ounces.

Progeny of G_1.—In Table I, G_1 is credited with nine tubers having a total weight of 28 ounces. At planting time in 1915 six of the tubers were rejected on account of being affected with an eye-rot of some kind. Eight plants (G_1a to G_1c_5) were obtained from the remaining three tubers. Of these, G_1a, from a tuber weighing only

three-fourths of an ounce, was the nearest normal and gave the largest yield, viz., 12.5 ounces. Up to July 12 this plant appeared entirely normal except in size. It was not as large as other normal plants. It never showed any symptoms of mosaic, but by July 26 the upper leaves on one stalk were showing pronounced symptoms of leaf-roll, and one stalk was nearly dead from an unknown cause. A third stalk was normal. The remaining seven plants were dwarfs severely affected with mosaic. Their average yield was 6.45 ounces.

Progeny of G_2.—The 28 plants constituting the progeny of G_2 were a motley lot. Some were clearly affected with mosaic; others were clearly affected with leaf-roll; while the condition of a few, though plainly abnormal, was difficult of diagnosis. (See G_2a to G_2m_5 in Table III.) Although none of the plants were entirely normal several gave a fair yield.

Owing to the small size of tubers a, b and c little could be expected of the plants from them. As a matter of fact, they were worthless. G_2d was affected with leaf-roll, but showed, also, some symptoms of mosaic. G_2e had a pronounced case of leaf-roll without any symptoms of mosaic. G_2f and G_2g, on the other hand, were severely affected with mosaic without any suggestion of leaf-roll. G_2h_1 was affected, probably, with leaf-roll; while G_2h_2 certainly had mosaic.

G_2i_1, G_2i_2 and G_2i_3 showed symptoms both of mosaic and of leaf-roll.

The three plants from tuber j (G_2j_1, G_2j_2 and G_2j_3) were of special interest because of the wide difference in the shape of the tubers. The tubers of G_2j_2 (seed-piece from middle of the tuber) were of normal shape, namely, flat-oblong; while those of G_2j_1 (seed-piece from stem-end) and G_2j_3 (seed-piece from bud-end) were so much elongated that they appeared to be of an entirely different variety. (See Plate X.) All three plants showed definite symptoms of leaf-roll without any indication of mosaic.

The other plants of this group, G_2k_1 to G_2m_5, were all clearly affected with leaf-roll, but the tubers were of normal shape.

Progeny of H_1 and H_2.—By reference to Table I it will be seen that H_1 and H_2 were dwarfs which yielded six and one-half and seven ounces respectively. One tuber of H_1 was rejected on account of its very small size. The other eleven tubers were planted whole. The resulting plants (H_1a to H_2e) were all dwarfs severely affected with mosaic. The leaves were small, wrinkled and yellowish green;

EXPLANATION OF PLATES.

PLATE II.— TUBERS OF GREEN MOUNTAIN JR. J_1. (1914).
From the same seed-tuber as the plant producing the tubers shown in Plate III. Tubers abnormally elongated.
Total weight, 23.5 oz. In 1915 these six tubers furnished seed for plants J_1a to J_1f_3, Table IV.
(One-half natural size.)

PLATE III.— TUBERS OF GREEN MOUNTAIN JR. J_2. (1914).
From the same seed-tuber as the plant producing the tubers shown in Plate II. Tubers of normal shape.
Total weight, 41.5 oz. In 1915 these ten tubers furnished seed for plants J_2a to J_2j_3, Table IV.
(One-half natural size.)

PLATE IV.— POTATO PLANTS AFFECTED WITH CURLY-DWARF.
Green Mountain Jr. A_3h_1 to A_3h_5, Table III, on July 16, 1915.
All five from the same seed-tuber.
(One-eighth natural size.)

PLATE V.— TUBERS OF CURLY-DWARF PLANTS.
Total yield of the five plants shown in Plate IV.
Weight, 7.7 oz.; 1–3–8a, b, c, d, e correspond to A_3h_1 to A_3h_5 in the text.
(Natural size.)

PLATE VI.— POTATO PLANT AFFECTED WITH CURLY-DWARF.
A stalk of Green Mountain Jr. B_3d_1 on June 25, 1915.
Leaves small, wrinkled and curled. Lower leaves dropping.
(Three-fifths natural size.)

PLATE VII.— NORMAL AND MOSAIC PLANTS.
Green Mountain Jr. J_2a, J_2b and J_2c. From three small tubers of the same plant. July 16, 1915.

PLATE VIII.— LEAVES OF NORMAL AND MOSAIC PLANTS.
From plants shown in Plate VII.
(Three-fourths natural size.)

PLATE IX.— YIELD OF NORMAL PLANT J_2a, SHOWN IN PLATE VII.
Total weight, 30.5 oz.
(About one-half natural size.)

PLATE X, FIG. 1.— YIELD OF THE TWO MOSAIC PLANTS SHOWN IN PLATE VII.
Total weight, 6 oz.
(About one-half natural size.)

FIG. 2.— TUBER NARROWED AT BUD-END.
From Green Mountain Jr A_3h_1: 1–2–7a corresponds to A_3h_1 in the text.
(Natural size.)

PLATE XI.— NORMAL AND ELONGATED TUBERS FROM THE SAME SEED-TUBER.
Green Mountain Jr G_3j_1 (elongated) at bottom; G_3j_2 (normal) in middle; and G_3j_3 (elongated) at top; 7–2–10a, 7–2–10b and 7–2–10c correspond to G_3j_1, G_3j_2 and G_3j_3, respectively, in the text.
(Four-sevenths natural size.)

PLATE XII.— TUBERS OF NORMAL AND MOSAIC PLANTS FROM SAME SEED-TUBER.
Green Mountain Jr. F_1e_4 (normal), 7 tubers at bottom; F_1e_2 (mosaic), 10 tubers at top; 6–1–5b and 6–1–5d correspond to F_1e_2 and F_1e_4, respectively, in the text.
(Four-sevenths natural size.)

PLATE XIII.— POTATO PLANT AFFECTED WITH LEAF-ROLL.
Unknown variety from Elmgrove. July 16, 1915.

Plate II.— Tubers of Green Mountain Jr. J_1. (1914.)
(See p. 118 for explanation)

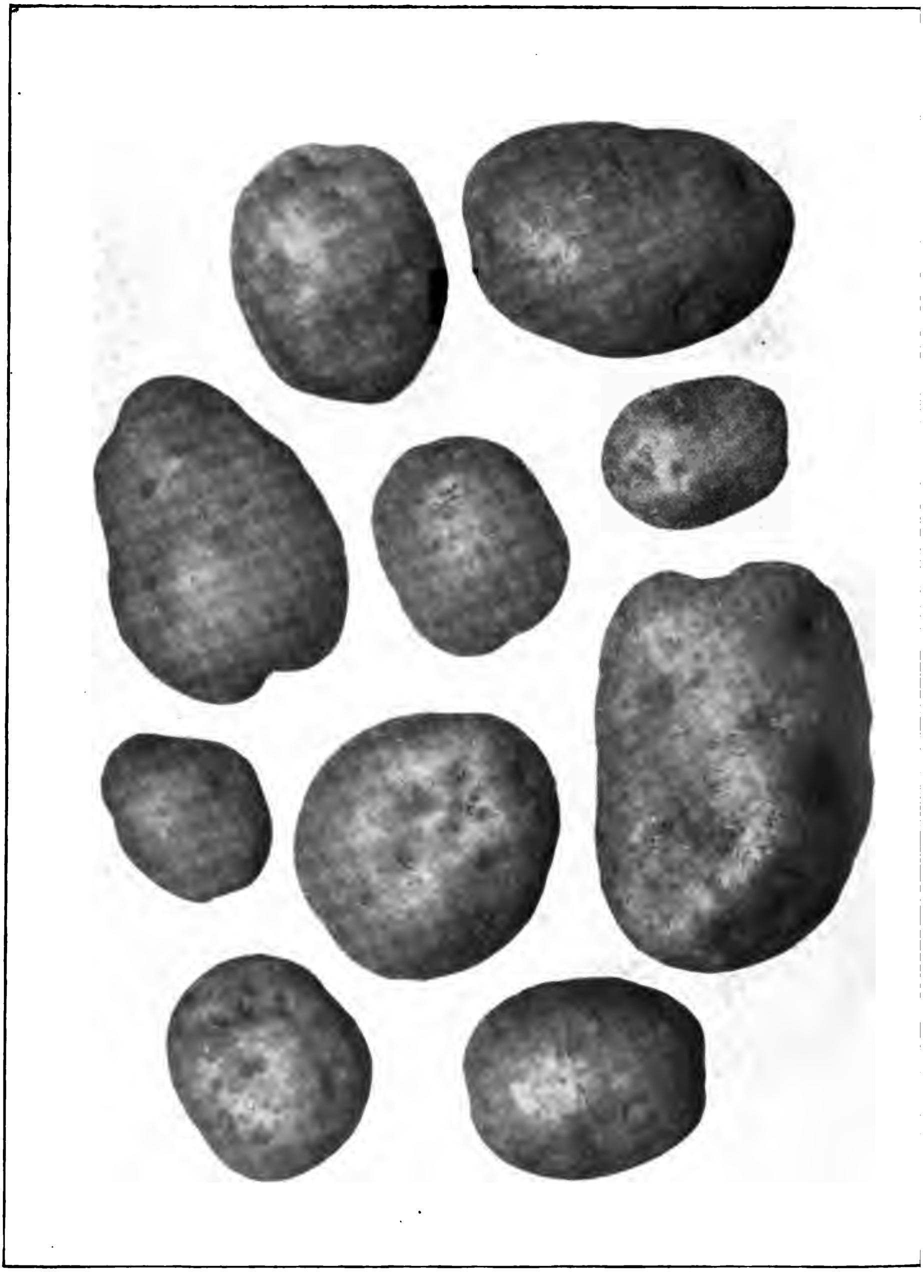

PLATE III.— TUBERS OF GREEN MOUNTAIN JR. J_2. (1914.)
(See p. 118 for explanation.)

Plate IV.—Potato Plants Affected with Curly-Dwarf.
(See p. 118 for explanation.)

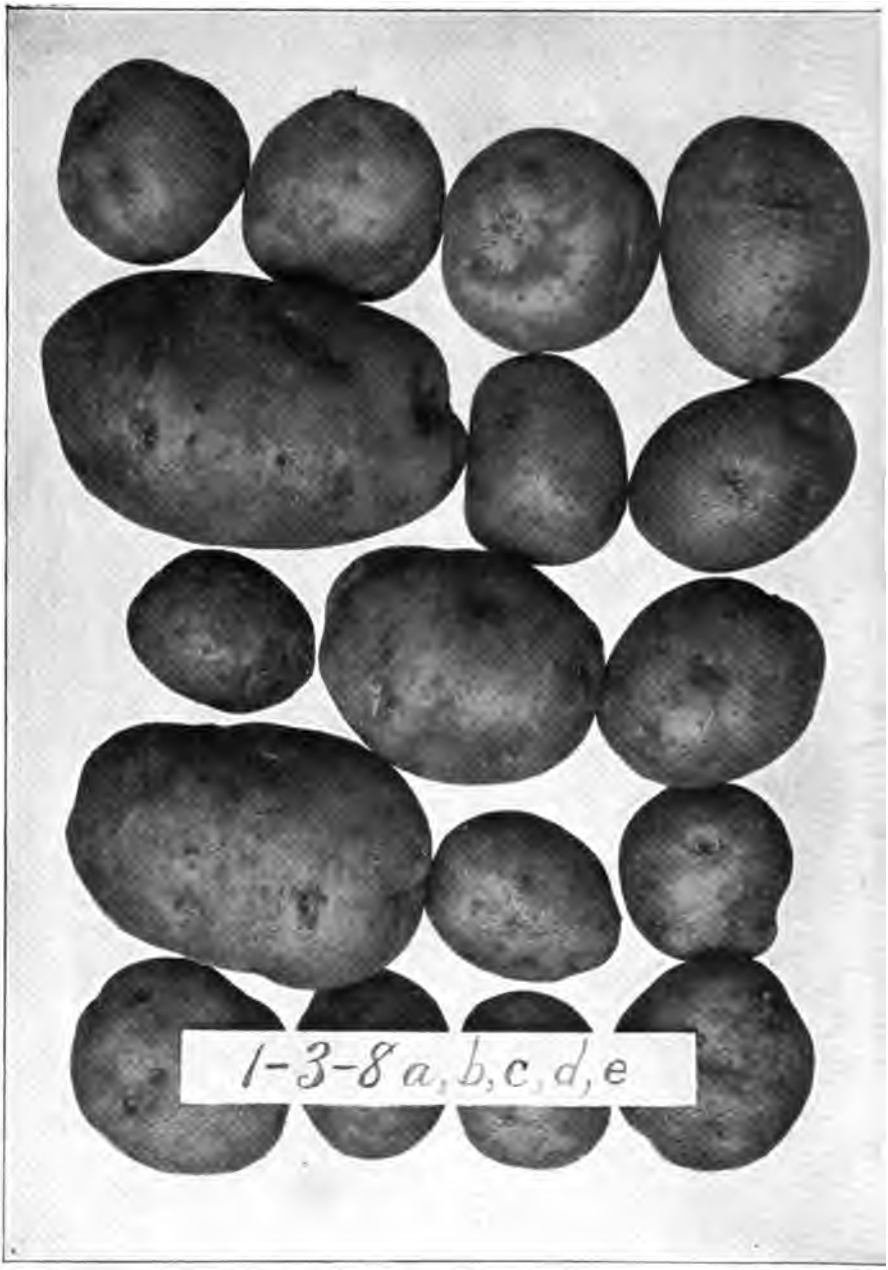

PLATE V.— TUBERS OF CURLEY-DWARF PLANTS.
(See p. 118 for explanation.)

PLATE VI.— POTATO PLANT AFFECTED WITH CURLY-DWARF.
(See p. 118 for explanation.)

PLATE VII.— NORMAL AND MOSAIC PLANTS.

(See p. 118 for explanation.)

Plate VIII.— Leaves of Normal and Mosaic Plants.
(See p. 118 for explanation.)

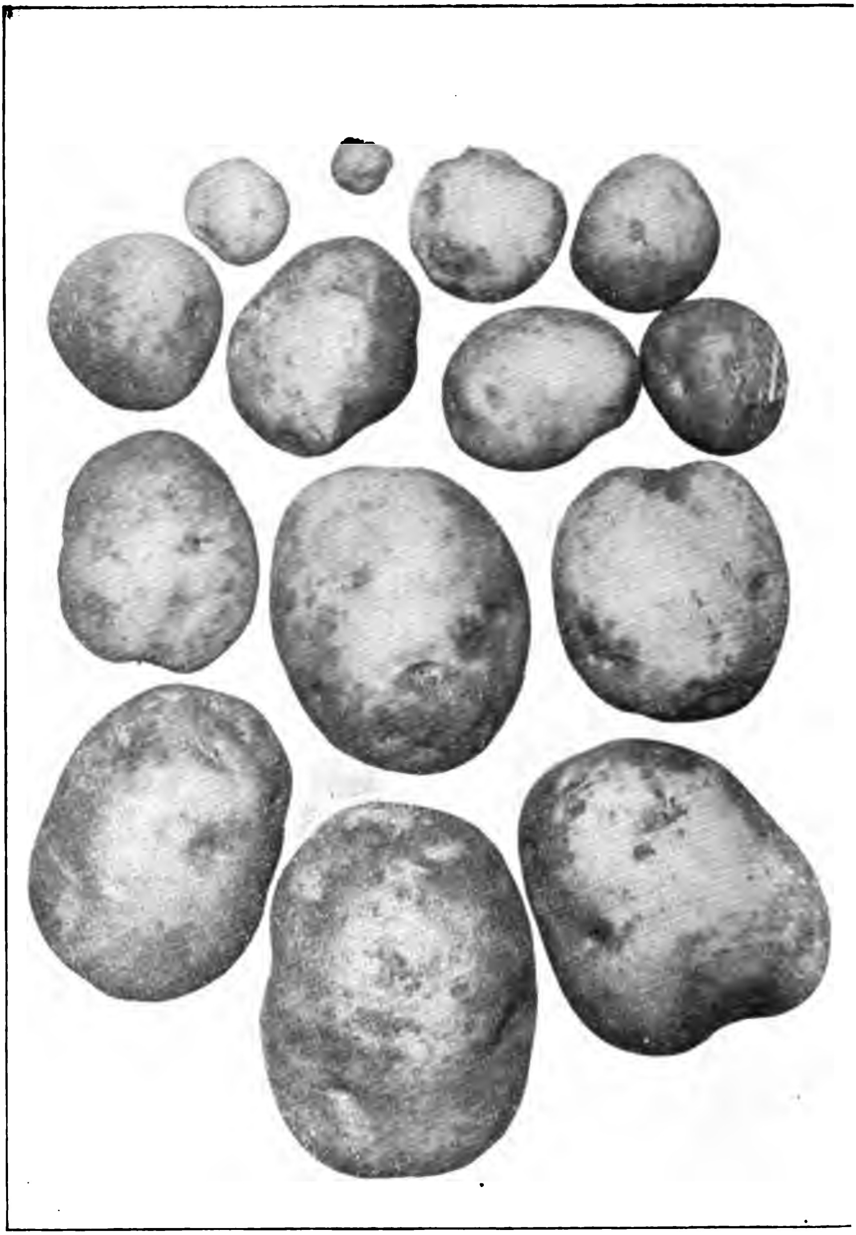

PLATE IX.— YIELD OF NORMAL PLANT J_2a, SHOWN IN PLATE VII.
(See p. 118 for explanation.)

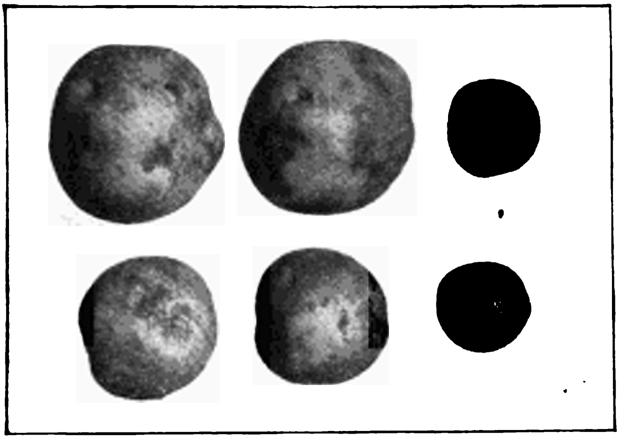

Fig. 1.—Yield of Two Mosaic Plants Shown in Plate VI.

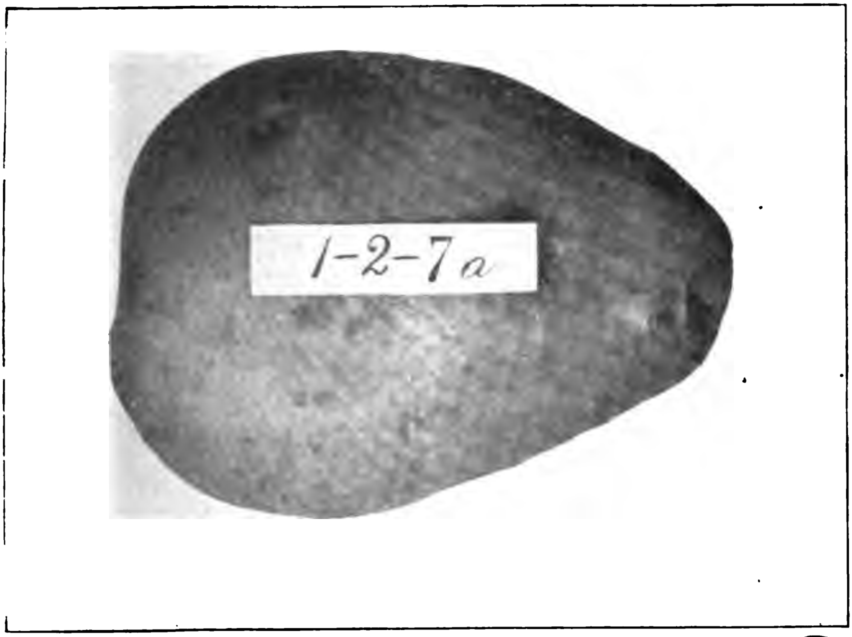

Fig. 2.—Tuber Narrowed at Bud-end.

Plate X.

(See p. 118 for explanation.)

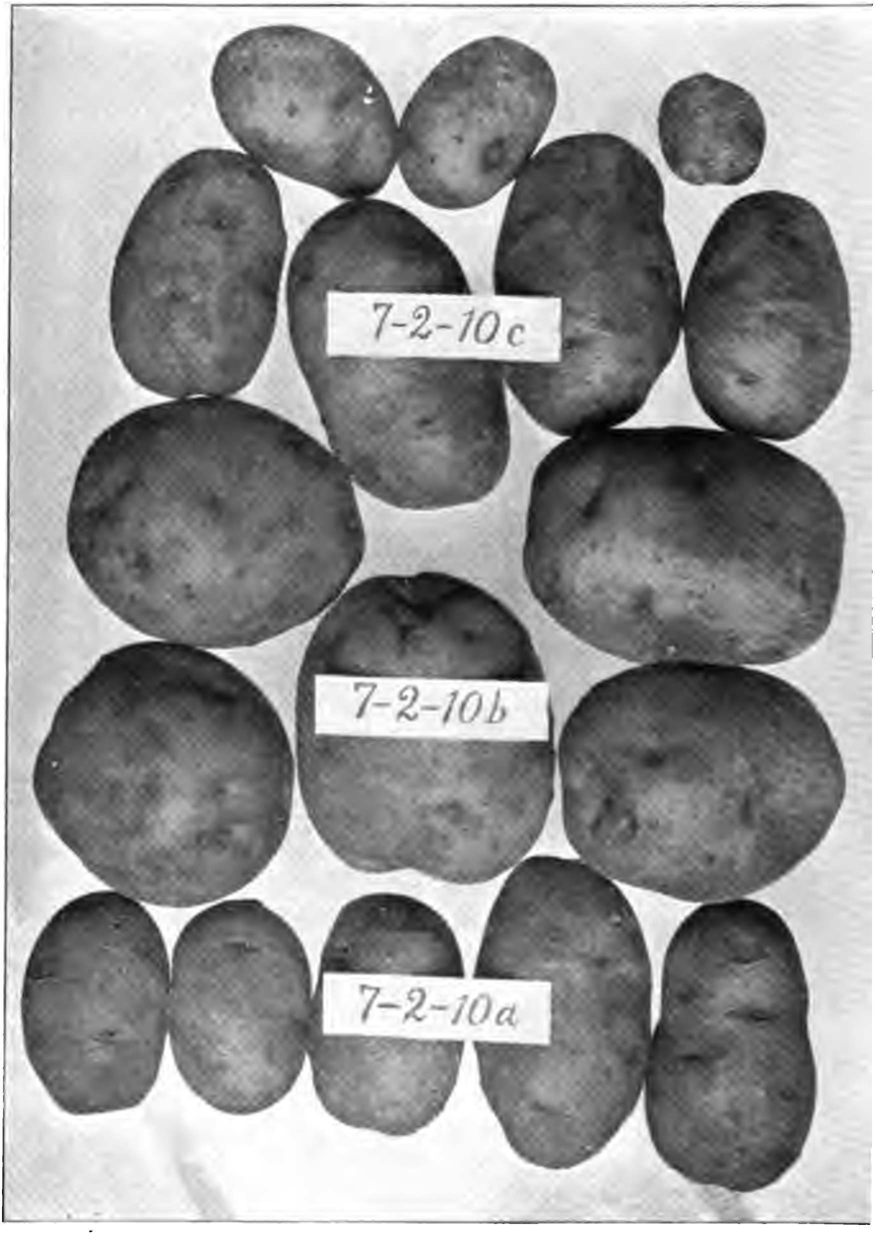

PLATE XI.— NORMAL AND ELONGATED TUBERS FROM THE SAME SEED-TUBER.
(See p. 118 for explanation.)

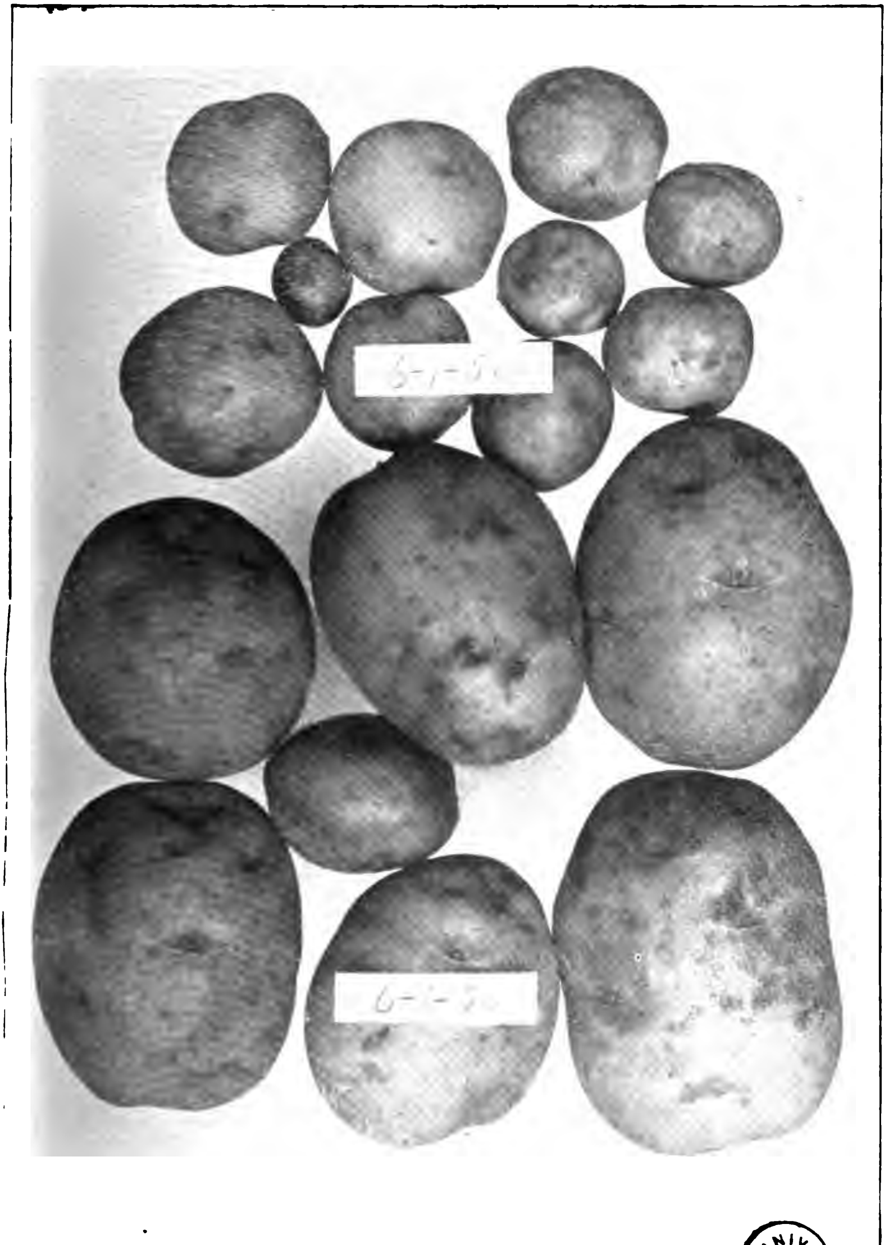

PLATE XII.— TUBERS OF NORMAL AND MOSAIC PLANTS FROM SAME SEED-TUBER.
(See p. 118 for explanation.)

PLATE XIII.— POTATO PLANT AFFECTED WITH LEAF-ROLL.
(See p. 118 for explanation.)

but they were not much curled and did not form bushy heads. The lower leaves dropped before July 1 giving the plants a trimmed-up appearance. It is interesting to note that the average yield, 6.57 ounces, was nearly as great as that of the parents. If we omit H_1a and H_2a, which were from extremely small tubers, the average yield of the remaining nine plants was slightly greater than that of the parents, namely, 7.47 ounces.

Progeny of I_1 and I_2.—It has already been related (page 99) how, in 1914, I_1 and I_2 seemed to represent a condition intermediate between that of the dwarfs and the normal plants; also, the remarkable elongation of the tubers has been mentioned. Their progeny proved to be as interesting and as puzzling as the parents. The twenty plants presented many variations in size, appearance and yield. (See I_1a to I_2e_2, Table III.) Some were undoubtedly affected with leaf-roll; others probably had it; and some others were certainly affected with mosaic. Some appeared normal until well into July and then developed leaf-roll. In most cases the tubers were elongated like those of the parent plants. Two plants, I_2c_2 and I_2e_2, outyielded the parents.

Progeny of J_1.—J_1 had puzzling foliage symptoms and elongated tubers like I_1 and I_2. (See page 99.) With one exception, its progeny of eleven plants were worthless dwarfs affected with mosaic. The exception, J_1f_1, though having no symptoms of mosaic, curly-dwarf or leaf-roll, was not quite normal. Late in July the leaves on the upper part of one stalk became thickly covered with small brown spots and died. The cause was not determined. The tubers of this plant were much elongated like its parent. The tubers of the other ten plants (the mosaic dwarfs) were not elongated, but it may be that they were too small to show their shape character.*

Progeny of J_2.—In some respects this group was the most interesting of the entire series. The parent plant, J_2, yielded ten tubers of normal shape and having a total weight of 41.5 ounces. These provided 21 seed-pieces for planting in 1915. Several more seed-pieces might have been made by cutting the larger tubers into pieces of the usual size, but on account of lack of space the number of plants was limited to 21 and large pieces used. J_2a, from the

* Even in normal hills in which the larger tubers have the type form, flat-oblong, the small tubers are, usually, nearly round. The flat-oblong shape does not appear until after the tubers have attained the weight of an ounce or more. Hence, the shape of small tubers has little significance.

smallest tuber of J_2, was the only one of the 21 plants which was normal. The other 20 were worthless dwarfs. The leaves of J_2a were large, flat and dark green; those of the dwarfs were small, wrinkled, curled and yellowish green. (Plate VIII.) On July 16 J_2a was a large, thrifty, spreading plant twenty inches high and holding all of its leaves. Its relatives were all trimmed-up, bushy-headed dwarfs ten inches high. (Plate VII.)

In Table III the twenty dwarfs are given as affected with mosaic. They certainly were affected with mosaic, but their curled leaves and bushy-headed condition led to the suspicion that they were affected also with curly-dwarf. Also, between July 5 and 12 several of the plants developed symptoms of leaf-roll.

J_2a yielded fourteen tubers of normal shape and weighing 30.5 ounces. The average yield of the 20 dwarfs was 3.47 ounces. (Compare Plates IX and X, fig. 1.)

BEHAVIOR OF OTHER VARIETIES FROM HONEOYE FALLS.

Besides the Green Mountain Jr., which was given special attention as described above, the progeny of a few plants of each of six other varieties from Honeoye Falls were kept under observation during 1915. " Normal " and abnormal hills of the 1914 crop of each variety were stored during the winter in paper bags in a cool cellar. In 1915 the pieces of each tuber and the tubers of each hill were planted together in the same manner as the Green Mountain Jr., but in another part of the Station farm. Brief mention will be made of the behavior of each variety.

State of Maine.—Of the variety State of Maine four " normal " and six abnormal hills were preserved for planting in 1915. The " normal " hills provided seed for 21 plants. Out of the total number of 77 plants only nine were normal. The other 68 were affected with mosaic. Most of the mosaic plants were dwarfs, but a few attained medium size and gave a fair yield. All of the normal and mildly-affected plants were from the " normal " hills of 1914. Every one of the 21 plants from abnormal hills was a tiny, worthless dwarf.

The progeny of " normal " hill E_1 are worthy of mention. E_1 contained six tubers having a total weight of 24 ounces. The

smallest two tubers were planted whole; the next largest two were cut into two seed-pieces each; and the largest two into five seed-pieces each, making a total of sixteen seed-pieces. The five plants from the largest tuber (which weighed eight ounces) were all large, normal plants. The other eleven plants of the group were all worthless dwarfs affected with mosaic. So, here we have an instance in which the largest tuber of the hill was the only one to produce normal plants.

Among the progeny of B_2 there was a striking example of normal and mosaic plants coming from the same tuber. Tuber k of B_2, weighing seven ounces, was cut into four seed-pieces which produced plants B_2k_1, B_2k_2, B_2k_3 and B_2k_4. B_2k_4 (from the bud-end piece) was a large plant which appeared entirely normal throughout the season and yielded eleven tubers weighing 52 ounces. B_2k_2 was a mosaic dwarf which yielded twelve small tubers weighing 5.5 ounces. B_2k_1 and B_2k_3 were plants of medium size, but distinctly affected with mosaic. Their yield was 32.5 and 24 ounces respectively. B_2k_1 had three normal stalks and two affected with mosaic.

Carman No. 2.—Four hills, two "normal" and two abnormal, of this variety were preserved for planting in 1915. The progeny of one of the "normal" hills (B_2), consisting of 21 plants, were all large and normal. Of the 21 plants from the other "normal" hill (B_1), 19 were of good size and showed only traces of mosaic; but one of the remaining two was a mosaic dwarf and the other, though of fair size, was clearly affected with the same disease.

The progeny of the two abnormal hills consisted of twelve plants eleven of which were severely affected with mosaic while the other had a bad case of leaf-roll.

Long Island Wonder.—The product of three "normal" and three abnormal hills of this variety were planted. The result was 72 plants of which all but one were small and abnormal—probably affected with mosaic. The remaining plant, D_3f_2, from a bud-end seed-piece of a tuber from a "normal" hill, was of large size and quite normal. It held all of its leaves which were large and flat and of dark green color. D_3f_1, from the stem-end piece of the same tuber, was plainly and severely affected with mosaic. Although the stalks were of medium height they bore only tufts of small, wrinkled, yellowish green leaves. The lower leaves had dropped early.

Knoxal.—Of this variety there was planted in 1915 the product of two "normal" and two abnormal hills from which 29 plants were obtained. The 21 plants from the two "normal" hills were all large and normal. The eight plants from the two abnormal hills were very small and plainly affected with mosaic.

Rural New Yorker No. 2.—Three "normal" hills (A_1, A_2 and A_3) and two abnormal hills (B_1 and B_2) were planted. The "normal" hills made 63 plants; the abnormal hills, six plants.

The progeny of A_1 were all normal plants.

The progeny of A_2 (23 plants) were partly normal and partly affected with mosaic; i. e., the six plants from the smaller tubers a and b (weighing about four ounces each) were mosaic dwarfs which gave an average yield of seven ounces per plant; while the 17 plants from the larger tubers c, d, e and f (total weight 31 ounces) were nearly or quite normal and gave an average yield of about 23 ounces.

The progeny of A_3 (21 plants) were all of good size, but most of them were mildly affected with mosaic. The seven plants from tuber c were of special interest. Six of these were large and normal, but the seventh (from the bud-end seed-piece), was clearly affected with mosaic.

The progeny of B_1 and B_2 were small and all affected with mosaic.

Late Victor.—This variety furnished yet another example of normal plants and mosaic plants coming from different tubers of the same hill. Three "normal" hills (E_1, E_2 and E_3) and six abnormal hills were planted. The normal hills made 42 plants; the abnormal hills, 13 plants.

The progeny of E_1 consisted of 15 plants from six tubers. The five plants from tubers a, b and e were very small and severely affected with mosaic; while the ten plants from tubers c, d and f were large and normal. The average yield of the mosaic plants was 4.4 ounces; that of the normal plants, 25.2 ounces.

The progeny of E_2 and E_3 were all large, normal plants.

The progeny of the six abnormal hills were all dwarfs severely affected with mosaic.

DEGENERATION IN VARIETY IONIA.

In a previous publication the writer* has described the behavior of a lot of Ionia potatoes some of which were supposed to have been severely affected with curly-dwarf in 1914. The tubers of affected plants were abnormally long and some of them, at least, produced spindling sprouts. Three of the most nearly normal† and fifteen of the most abnormal hills were preserved for planting in 1915.

From the three "normal" hills 99 plants were obtained; from the 15 abnormal hills, 73 plants. All tubers of abnormal hills were planted without cutting.

The progeny of one of the "normal" hills were all large, normal plants with large, flat, dark green leaves. Their average yield was 35 ounces which is at the rate of 419 bushels per acre. The tubers were quite variable in shape. Some were flat-oval or flat-oblong; some long and pointed at both ends; some dumb-bell shaped; some strongly narrowed at the stem-end and some at the bud-end.

The progeny of another "normal" hill were of fair size, but not entirely normal. Several showed mild symptoms of leaf-roll.

Among the progeny of the third "normal" hill there were five plants which appeared normal; but the others were much smaller than normal, of light green color and most of them showed a strong upward rolling of the upper leaves. There were no symptoms of mosaic or curly-dwarf.

With one notable exception the 73 plants from the abnormal hills were very small and abnormal though it was not quite clear what ailed them. None of them dropped their lower leaves. None were affected with mosaic and none were typical curly-dwarfs. Most of them showed more or less upward rolling of the leaves and all were lighter green than normal. They did not have the downward curling of the leaves and bushy-headed habit of growth which had characterized their parents. Their symptoms were those of leaf-roll rather than those of curly-dwarf. Their yield was very small. Most of the tubers were abnormally elongated as in 1914.

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* Stewart, F. C. and Sirrine, F. A. The spindling-sprout disease of potatoes. N. Y. (Geneva) Sta. Bul. 399:141. 1915.

† Judging from the appearance of the foliage it might have been doubted that these plants were entirely normal; but their enormous yield of 69, 62.5 and 55 ounces is proof that they had no more than a very mild attack of any disease. The average yield of the first five abnormal plants was nine ounces. The other ten were not weighed.

The one exception to the above was in the progeny of abnormal hill No. 3. This hill contained four tubers (total weight nine ounces) which were planted whole. The plants from seed-tubers a, b and c were very small, of light green color and plainly affected with leaf-roll. They yielded 1.5, 8.5 and 6.75 ounces respectively. The plant from seed-tuber d (weighing 3.5 ounces) was large and normal with large, flat, dark green leaves. It gave the extraordinary yield of 71.5 ounces.

OBSERVATIONS ON AN UNKNOWN VARIETY AFFECTED WITH LEAF-ROLL.

In September, 1914, at Elmgrove, N. Y., the writer had an opportunity to study a field of potatoes (variety unknown) severely affected with leaf-roll. About 90 per ct. of the plants were affected. Though of fair size they were distinctly smaller than the normal plants scattered here and there through the field. On affected plants all of the leaves were conspicuously rolled upward and many had a narrow strip of dead, brown tissue around the margin; whereas, the leaves of normal plants were flat and free from marginal browning. The contrast in appearance between normal and affected plants was very striking. The stems and tubers of affected plants were carefully examined for indications of parasitic organisms which might account for the leaf-roll symptoms, but none were found. There were no lesions or discoloration of any kind. The leaves, also, were nearly or quite normal in color except for the browning of the leaf-margins. Neither were there any soil conditions which could be held responsible for the trouble. It seemed to be a clear case of genuine leaf-roll.

To test the hereditary character of the trouble 19 tubers from affected plants were brought to Geneva and planted in good soil. They were given good cultivation and suffered neither from a lack of water nor from an excess of it. Every plant developed pronounced symptoms of leaf-roll without any indication of mosaic or curly-dwarf. (See Plate XIII.) The plants were small and gave a low yield.

RAPID DEGENERATION IN A STRAIN OF PRIDE OF VERMONT.

In the spring of 1913 the writer planted in his garden at Geneva a single tuber of the variety Pride of Vermont. This tuber was supposed to belong to a prolific strain. It came from a crop which won second prize for high yield in a potato-growing contest in Connecticut. The plants produced in 1913 were of large size, normal in foliage and gave a good yield. The entire product was planted in 1914. This season, also, the plants appeared normal, but their yield was only fair. The crop of 1914 was stored in paper bags, each hill in a separate bag. In the spring of 1915 three hills (the contents of three bags) were planted. Fourteen other hills were left in the bags in the cellar to see what kind of sprouts the tubers would produce as it was suspected that there was something wrong with them.

The plants produced in 1915 varied considerably in size, but all were decidedly smaller than normal and some were mere dwarfs. Aside from their small size there was nothing abnormal about their appearance except the rolling of the lower leaves which was quite conspicuous. None of the lower leaves dropped and there were no symptoms of mosaic or curly-dwarf. Yet they died prematurely and the yield on a row forty feet long was only 7.75 pounds of small tubers, none of which weighed over 2.5 ounces. For all practical purposes the strain was completely " run out."

The tubers which had been left in the cellar nearly all produced very slender sprouts. In twelve of the fourteen bags no tubers sprouted normally. On the majority of the tubers in these bags there was one fairly robust sprout at the bud-end while all of the other sprouts were spindling, many of them being exceedingly slender. On some tubers all of the sprouts were spindling. Two hills (two bags) were exceptions to the rule in that they contained some tubers with spindling sprouts and others with robust sprouts. One of these hills contained seven tubers—all of marketable size. The largest two tubers produced only spindling sprouts of the extreme type, while the other five produced only robust sprouts. The other exception, also, contained seven tubers, four of them of marketable size and three which weighed less than two ounces each. In this hill one of the small tubers, weighing less than one ounce, sprouted normally. The other six produced spindling sprouts.

RAPID DEGENERATION IN A STRAIN OF GREEN MOUNTAIN.

A tuber from the crop which won first prize in the contest mentioned on page 125 was planted in 1913 in the writer's garden under conditions parallel with those surrounding the Pride of Vermont just described. This was a medium-sized tuber of the variety Green Mountain. It was cut into two seed-pieces, but the plant from one piece was accidentally destroyed. The other plant grew to large size and appeared normal. No record was made of the weight of the tubers produced, but the yield was satisfactory. This is shown by the fact that it furnished material for 63 good-sized seed-pieces in 1914. Thirty-six of these seed-pieces were planted in one row beside the Pride of Vermont above mentioned. Throughout the season of 1914 the plants were kept under close observation. A careful watch was kept for the appearance of disease, because it was planned to use the product for seed in a cooperative experiment which had been arranged with the Maine Station and it was necessary that the seed used should be free from all diseases which might be transmitted through the seed. Every one of the plants was thought to be normal. They were of good size, fairly uniform and free from curling, rolling or wrinkling of the leaves. The color of the leaves was normal. By September 10 the leaves of all of the plants were much browned around the margin. While this did not seem to be warranted by the weather and soil conditions it was not regarded as an indication of disease. It was thought to be the commencement of the process of natural maturation. Since planting was done on May 23 the plants were 110 days old at this time.

The yield, though fair, was not as large as it should have been. The yield of individual plants varied from 9.5 ounces to 33.5 ounces, the average being 19.9 ounces, which is at the rate of 289 bushels per acre.

During the winter the tubers of each of the 36 plants were stored in separate paper bags in a moist, cool cellar.

In the spring of 1915 the 36 hills were divided into three lots of 12 each. One lot was sent to Riverhead, Long Island, to be planted there; a second lot to Cadyville in the northeastern part of New York; and the third lot to Presque Isle, Maine. At Riverhead, the

potatoes were in the care of Mr. F. A. Sirrine and the writer; those sent to Cadyville, in care of Mr. C. B. Tillson, Farm Bureau Agent for Clinton County; and those sent to Maine, in care of Dr. W. J. Morse and Mr. M. Shapovalov representing the Maine Experiment Station.

At all three places most of the plants were decidedly abnormal. At Riverhead, twelve plants (in two tuber-units) appeared normal. The other 257 were all undersized, some being worthless dwarfs. Though frequently much wrinkled, the leaves were of normal color and showed no tendency to drop prematurely. Some plants had a compact habit of growth and slight curling of the leaves suggestive of curly-dwarf, but not the bushy-headed condition characteristic of typical curly-dwarf. While the plants were plainly abnormal their condition could not be ascribed to any disease with which the writer is acquainted.

The plants at Cadyville were in practically the same condition as those at Riverhead. They were very uneven in size and all abnormal. When the writer saw them on July 20 he was unable to identify the disease with which they were affected.

The plants grown in Maine, also, were decidedly abnormal but presented somewhat different symptoms. In notes made on August 1 Dr. Morse recorded many plants as showing a tendency to curly-dwarf and several as affected with spindling-sprout disease. He observed that the petioles of the leaves on some plants were abnormally brittle. A few plants showed slight symptoms of mosaic.

SPROUTING TEST.

In order to obtain information concerning the relation of spindling-sprout to the several forms of degeneration, the various lots of degenerate potatoes above described were given an opportunity to sprout. On April 28, 1916, they were removed from the cool, damp cellar in which they had been stored during the winter and placed in a greenhouse. The potatoes were in paper bags, each hill in a separate bag. They were well protected from the light. A month later the character of their sprouting was studied.

Green Mountain Jr.—On all of the progeny of tuber A the sprouts were normally robust with the following exceptions: In A_1f_1 three of the larger tubers had some spindling sprouts. The plant which

produced these tubers was thought to be affected with leaf-roll. In A_2g_4 one tuber had one fairly robust sprout from the bud-end, but other sprouts from near the middle of the tuber were quite spindling. The plant producing this tuber also was affected with leaf-roll. All four tubers of A_3h_5 had abnormally slender sprouts. The plant producing these tubers was affected with curly-dwarf.

Among the progeny of tuber B spindling sprouts were observed in the following cases: One tuber of B_1c_3, a plant affected with curly-dwarf, had abnormally slender sprouts; some tubers of B_1e_2 and B_1e_4, plants affected with leaf-roll, had abnormally slender sprouts; three tubers of B_2e_1, a plant affected with mosaic, showed a tendency to spindling-sprout; two tubers of B_2f_6, a plant affected with mosaic, had some sprouts which were fairly robust and others which were very slender; one tuber each of B_3f_4 and B_3f_5, plants affected with mosaic, had one fairly robust sprout from the bud-end while the other sprouts were very slender.

Among the progeny of tuber C there were only two cases of spindling-sprout, viz.: C_1b, affected with mosaic, one tuber; and C_1e, also affected with mosaic, two tubers

None of the progeny of tubers D and E showed any tendency to spindling-sprout.

Among the progeny of tuber F there were a few tubers showing slight symptoms of spindling-sprout, viz.: some tubers of F_1d_3, affected with mosaic; of F_1e_5, affected with leaf-roll; of F_1f_3, nature of abnormality undetermined; and of F_1g_1, F_1g_2, F_1g_3, and F_1g_4, normal plants.

Coming to the progeny of tuber G we are confronted with additional vagaries of G_2j_1, G_2j_2 and G_2j_3. As related on page 340 these three plants came from the same seed-tuber and all were affected with leaf-roll; but the tubers of G_2j_1 and G_2j_3 were very much elongated while those of G_2j_2 were of the normal, flat-oblong shape. (Plate XI). The inference naturally drawn from this sudden change in tuber form is that the plants G_2j_1, and G_2j_3 were abnormal. Accordingly, we were surprised to find the abnormal tubers of G_2j_1, and G_2j_3 sprouting normally, while the normal tubers of G_2j_2 had a strong tendency toward spindling-sprout.

Other examples of spindling-sprout in the G progeny were seen in two tubers each of G_2k_1 and G_2l_1, both affected with leaf-roll.

The progeny of tuber H all sprouted normally.

The progeny of tuber I, also, seemed to be sprouting normally except that on five tubers of one plant, I_2c_2, the sprouts had barely started. Two other tubers of the same plant had short, robust sprouts.

The progeny of tuber J all sprouted normally.

State of Maine.—The tubers of ten plants of the B_2 group, including five mosaic dwarfs, were sprouted. All sprouted normally. Sprouts from the stem-end were nearly as robust as those from the bud-end.

Late Victor.—Tubers of ten normal and five mosaic plants of this variety were sprouted. None showed any indication of spindling-sprout.

Rural New Yorker No. 2.—All of the tubers from three normal and six mosaic plants sprouted normally.

Ionia.—Tubers of six normal and thirty-five abnormal plants of this variety were sprouted. In most cases the larger tubers of abnormal plants had a single slender sprout one to three inches long at the bud-end; while on many of the small tubers the sprouts had barely started. The sprouting of all of them was clearly abnormal. On tubers of normal plants the bud-end sprouts were robust, but sprouts from the lateral and stem-end eyes were often decidedly slender.

Leaf-roll potatoes from Elmgrove.—Every tuber of the thirty-six plants of this variety (name unknown) appeared to be sprouting normally.

Pride of Vermont.—In this variety each tuber had a single fairly robust sprout three-fourths of an inch to two inches long at the bud-end. The sprouting may have been normal, but the writer hesitates to accept it as such without having seen sprouts from the lateral eyes.

Green Mountain.—Of this variety there were sprouted only the tubers of twenty-three plants grown at Riverhead. Eleven of these plants were markedly abnormal. Nevertheless, all of the tubers sprouted normally with robust sprouts four to six inches long.

DISCUSSION OF THE RESULTS.

Although spindling-sprout symptoms appeared occasionally in the tubers of plants affected with mosaic, leaf-roll and curly-dwarf they were too infrequent to warrant the conclusion that spindling-

sprout is correlated with any one of these three diseases. On the other hand, it appears that spindling-sprout does have some relation to the abnormality appearing in the varieties Ionia and Pride of Vermont. In the case of the variety Green Mountain the data are insufficient to form the basis of an opinion.

STEM-END BROWNING AND NET NECROSIS.

At the conclusion of the sprouting test all tubers were examined for stem-end browning and other forms of internal discoloration. If the leaf-roll symptoms observed were due to Fusarium or Verticillium wilt the tubers should show stem-end browning.

In the variety Green Mountain Jr. there were fourteen tubers from twelve plants which showed stem-end browning more or less definitely. In five tubers it was quite definite; in the other nine, slight. In no case was there any rot. The discoloration took the form of brown streaks radiating from the stem and extending a short distance into the flesh of the tuber. The affected tubers came from the following plants: A_1g_4, A_2g_3, A_3h_3, C_1b, F_1c_2, F_1e_2, F_1g_3, I_2c_2, J_1a, J_1b_1, J_1b_2 and J_1c_1. By referring to Table III it will be seen that only two of these plants showed leaf-roll symptoms. The tubers of the great majority of the plants with leaf-roll symptoms were free from stem-end browning. Plainly, stem-end browning of the tubers was not associated with the rolling of the leaves.

Another kind of tuber discoloration was found in 62 tubers from 37 plants of the variety Green Mountain Jr. This appeared in the form of brown spots in the flesh of the tuber. For the most part, the spots occurred outside the vascular ring just beneath the skin and were distributed throughout the whole length of the tuber. Generally, though not invariably, affected tubers could be detected readily by the appearance of small, angular or irregular, slightly-depressed, brown or dark-colored spots on the surface marking the location of brown spots in the flesh beneath.

It was not noticed at digging time although the tubers were handled much during the washing, weighing and counting to which they were subjected at that time. Neither was any such trouble observed in the crop of 1914. It was not correlated with any particular form of the degeneration. Some of the affected tubers came from mosaic, some from leaf-roll and some from curly-dwarf plants.

This trouble appears to be one of the forms of internal browning to which Orton * has given the name "net necrosis."

No discoloration of any kind was found in any of the tubers of any of the other lots of potatoes used in the sprouting test.

SUMMARY OF THE EVIDENCE ON THE INHERITANCE OF THE SEVERAL FORMS OF DEGENERATION.

The progeny of plants severely affected with mosaic or curly-dwarf were almost invariably very abnormal, most of them being worthless dwarfs. Forty-seven plants, representing eight varieties badly diseased in 1914, produced, in 1915, 197 plants all but one of which were very badly diseased. Some were affected with mosaic, some with curly-dwarf and some with other (unidentified) forms of degeneration. The one exception was a perfectly normal plant which came from one of the four tubers of a badly diseased plant of the variety Ionia. (See page 124).

Leaf-roll, also, is heritable. The progeny of nineteen tubers from plants affected with leaf-roll were all severely affected with leaf-roll. (See page 124).

Plants apparently normal may produce only abnormal progeny. In several instances plants of large size, normal foliage and high yield gave only badly diseased progeny. Examples of this occurred in Green Mountain Jr. A_2, A_3, B_1, B_2, B_3, F_2, F_3, G_1, G_2, State of Maine and Long Island Wonder. Experience with Pride of Vermont (page 125) and Green Mountain (page 126) indicates that perfectly normal foliage is not a guaranty that the progeny will be normal.

In general, the several plants from different pieces of the same seed-tuber were similar in character; but there were some exceptions as noted below.

Normal and leaf-roll plants may come from different tubers of the same plant (Green Mountain Jr. A_1, F_1 and Ionia); and even from different pieces of the same tuber (Green Mountain Jr. F_1e and F_1f).

Normal and mosaic plants may come from different tubers of the same plant. Examples: Green Mountain Jr. A_1, F_1, J_2; State of Maine (page 121); Long Island Wonder (page 121); Rural New Yorker No. 2 (page 122); and Late Victor (page 122).

*Orton, W. A. Potato wilt, leaf-roll, and related diseases. U. S. D. A. Bul. 64:14. 1914.

Normal and mosaic plants may come from the same tuber. Examples: State of Maine B_2k (page 122) and Rural New Yorker No. 2 (page 121.)

Normal, leaf-roll and mosaic plants may come from the same tuber. Examples: Green Mountain Jr. F_1e and B_2d.

Mosaic and leaf-roll plants may come from different tubers of the same plant. Examples: Green Mountain Jr. A_1, A_2, A_3, F_1, G_1, G_2, I_1, I_2; and Carman No. 2 (page 121).

Mosaic and leaf-roll plants may come from the same tuber. Example: Green Mountain Jr. A_3d.

Mosaic and curly-dwarf plants may come from different tubers of the same plant. Examples: Green Mountain Jr. A_3 and B_3.

Leaf-roll and curly-dwarf plants may come from different tubers of the same plant. Examples: Green Mountain Jr. A_3 and B_1.

Mosaic, leaf-roll and curly-dwarf plants may come from different tubers of the same plant. Example: Green Mountain Jr. A_3.

Mosaic, leaf-roll and curly-dwarf plants may come from the same tuber. Example: Green Mountain Jr. B_1e.

Normal and spindling sprouts may come from different tubers of the same plant and even from the same tuber. Examples in Pride of Vermont, Ionia and Green Mountain Jr.

The abnormal elongation of tubers is heritable, but not correlated with mosaic, curly-dwarf or leaf-roll. Examples: the progeny of Green Mountain Jr. I_1, I_2 and J_1 and Ionia (page 123). From the same (normal) tuber may come plants producing only normal (flat-oblong) tubers and plants producing long, slender tubers. Examples: Green Mountain Jr. J in 1914 (page 99) and Green Mountain Jr. G_2j in 1915 (page 118).

Pronounced narrowing of the tubers toward either the stem-end or the bud-end is not a symptom of leaf-roll, curly-dwarf or mosaic. While the evidence furnished by the progeny of Green Mountain Jr. A_1f, A_2g, A_2h and A_2i (Table III) suggests an intimate relation between leaf-roll and pointed tuber ends, numerous other plants affected with leaf-roll bore only tubers of normal shape. In this connection it should be mentioned that tuber A, from which came plants A_1, A_2 and A_3 (Table I) and their progeny A_1a to A_3i_5 (Table III), was strongly narrowed at the stem end.

Sprouting tests of tubers from leaf-roll, curly-dwarf and mosaic plants show that spindling-sprout is not a symptom of these diseases.

NATURE OF THE SEVERAL FORMS OF DEGENERATION.

Throughout this paper the writer has attempted to use the names leaf-roll, mosaic and curly-dwarf in the same sense that they were used by Orton in his Bulletin No. 64. In some cases it was found very difficult to distinguish between mosaic and curly-dwarf. The typical forms of these two diseases seem to be connected by intergrading forms. The brittleness of the stems, given by Orton as one of the symptoms of curly-dwarf, we were unable to test owing to the necessity of preserving the plants to determine their yield.

It may be doubted that the plants said to have been affected with leaf-roll were, in all cases, actually affected with the true leaf-roll described by Orton, because the transmissibility of the disease through the tubers has not been tested. Orton says: "The true leaf-roll is heritable." The most that can be said for the accuracy of our diagnosis is that all other known causes of the rolling of potato leaves seem to have been eliminated.

It is not impossible, also, that tubers from different plants may, sometimes, have been mixed accidentally; but the utmost care was taken to avoid such errors.

Assuming accuracy in these two respects the data presented indicate that leaf-roll, mosaic and curly-dwarf are closely related disorders due to the same general cause*. What that cause may be we do not know. However, it may be confidently stated that it is not an organism of any kind. The writer has seen no evidence that any one of the three forms of degeneration is communicable from one plant to another except through the seed-tuber. Neither

* The manuscript of this bulletin was read by Mr. W. A. Orton. In a letter to the writer, dated June 21, 1916, he makes the following comments which he has given us permission to publish in this connection:

"Since the publication of my Bulletin 64, it has become apparent that a further subdivision of these deterioration troubles is possible. We now recognize several types of dwarfing in addition to the true curly dwarf. Leaf roll in its last stages produces a dwarf plant and the progeny of the mosaic hills includes many dwarfed and bushy types which might have been called curly dwarfs a few years ago. There is also a type marked by lack of vigor, small, weak, undeveloped growth without distinct rosetting or bushiness which ought to be set apart from the others.

"I do not feel that the relation between leaf roll and mosaic is sufficiently proved by your observations to justify the unrestricted conclusions you have given, since if it should be shown later on that mosaic is communicable like the tobacco mosaic, a combination of this trouble with leaf roll or curly dwarf would be explained. Then, there is the further contradictory evidence which we have secured in connection with Prof. William Stuart's plots that whereas leaf roll and curly dwarf were abundant in the seedlings over an area of ten acres, no mosaic whatever was ever observed."

can the cause be ascribed to any weather or soil condition of the current season. Normal and affected plants may grow side by side in the same soil under the same weather conditions. Their hereditary character and the fact that normal and affected plants may come from different buds of the same tuber suggest that all three forms of degeneration have their origin in bud-variation. On the other hand, the fact that plants may be affected with leaf-roll and mosaic in widely different degrees is opposed to this view. Usually, bud-varieties are more constant in their characters. Also, it is very unusual for the same sort of bud-varieties to occur so frequently as do these three kinds of degenerate potato plants.

In this paper, plants showing the several forms of degeneration have been referred to frequently as " diseased " plants. The use of the word *disease* in this connection is merely a matter of convenience and is not to be construed as indicating that the writer regards the abnormality in question as a pathologic condition. It may be or it may not be such—we do not know.

In Orton's excellent paper previously mentioned will be found a discussion of the several hypotheses which have been advanced to account for the appearance of leaf-roll and curly-dwarf: also, references to the literature of the subject.

BEARING ON THE SELECTION OF SEED POTATOES.

The best known method of combating leaf-roll and curly-dwarf is that of using for seed only tubers of normal plants. Undoubtedly, these and some other forms of disease and degeneration may be largely eliminated by the judicious selection of seed. Many potato growers who raise their own seed potatoes practise hill-selection with satisfaction and profit; and those who buy their seed are beginning to look upon certified seed potatoes as the best solution of their seed-potato problem. The subject of seed selection is one of much interest at present. What light does this study throw upon it?

First: It is plain that high yield, alone, is not a guaranty of productivity in the progeny of the following season. Neither is the possession of normal foliage by a plant a sure indication that its progeny will be normal. Degeneration may occur quite suddenly. This is one reason why " selected " seed and " certified " seed sometimes fail to give satisfaction.

Second: It is unsafe to select seed potatoes from fields in which the plants are very uneven in size. The small plants in such fields are usually degenerates and their appearance in large numbers is an indication that the strain is in the process of degeneration. Even the normal plants in such fields may produce worthless progeny as happened with Green Mountain Jr. and some other varieties in our experiments.

Third: The mosaic disease threatens to become an important factor in the production of seed potatoes. It is very common in the seed-potato fields of Maine and northern New York. Long Island buyers of northern-grown seed suffer heavy losses from it. Through the experiments of Wortley* and the observations recorded in this bulletin, it has been established that mosaic is transmitted through the seed tubers. Hence, it is important that all severely-affected plants, at least, be eliminated from seed-potato fields. It is not yet clear as to what may be expected of the progeny of plants slightly affected with mosaic. If, as now seems probable, tubers of slightly-affected plants are liable to produce worthless mosaic dwarfs, it will become necessary to make very strict rules regarding mosaic in the inspection of certified seed potatoes. Unfortunately, mild cases of mosaic are frequently difficult of detection.

Fourth: It is often stated that potatoes will not " run out " if rigorous seed selection is practised. The writer's experience with the degenerate strains herein described lead him to question the accuracy of this statement. It seems impossible that the degeneration of the Green Mountain and Pride of Vermont described on pages 125-127 could have been prevented by any method of seed selection. It is our opinion that, under certain conditions, potatoes will " run out " in spite of anything which can be done.

* Wortley, E. J. The transmission of potato mosaic through the tuber. *Science* n. s., 42:460-461. 1915.

TREE CRICKETS AS CARRIERS OF *Leptosphaeria coniothyrium* (Fckl.)* Sacc. AND OTHER FUNGI.†

W. O. GLOYER AND B. B. FULTON.

SUMMARY.

The name tree-cricket canker is proposed for a disease of apple branches in which areas of dead bark infested with ***Coniothyrium fuckelii*** Sacc. surround the oviposition punctures of tree crickets (***Œcanthus*** spp.). The constant association of ***C. fuckelii*** with such cankers aroused the suspicion that tree crickets act as carriers of the fungus. Through investigations herein described this suspicion has become an established fact. It has been shown that they may carry ***C. fuckelii*** from raspberries to apple trees and infect them. Also, that they carry within the digestive tract and on the outside of their bodies spores of many other kinds of fungi. Spores and fragments of mycelium of many kinds of fungi have been found in the excrement of tree crickets captured in the field and in excrement covering the oviposition punctures of the tree crickets. Many of these spores were viable,— germinating readily in drops of water.

In feeding experiments, spores of ***Ustilago zeae*** (Beckm.) Ung., ***Coprinus micaceus*** (Bull.) Fr., ***Coniothyrium fuckelii*** Sacc., ***Nummularia discreta*** Tul. and ***Sphaeropsis malorum*** Pk. passed through the digestive tract of tree crickets without loss of viability.

Typical cankers resulted when tree crickets fed on ***Coniothyrium fuckelii*** were permitted to oviposit on apple branches. The percentage of oviposition punctures resulting in cankers was considerably greater when the insects were fed with ***C. fuckelii*** on raspberry canes than when they were fed with pure cultures of ***C. fuckelii*** isolated from apple branches. The oviposition punctures of ***Œcanthus niveus*** gave a higher percentage of infection than did those of ***Œ. angustipennis;*** and for both species the percentage of infection was considerably higher when the punctures were covered with grafting wax than when they were left unprotected.

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* In this paper *Coniothyrium fuckelii* Sacc., the name given to the pycnidial stage of *Leptosphaeria coniothyrium* (Fckl.) Sacc., is frequently used as a matter of convenience when reference is made to the pycnidial stage of the fungus.

† A reprint of Technical Bulletin No. 50, March, 1916.

Typical cankers have been produced artificially, also, by inserting pellets of tree-cricket excrement into punctures made in apple branches with a sterile instrument and covering them with grafting wax.

Clean cultivation and the use of arsenical sprays as for codling moth appear to be the only remedial measures required for the control of the tree crickets.

REVIEW OF LITERATURE.

That the various species of tree crickets (*Œcanthus* spp.) disseminate plant diseases has been suggested by previous writers, but in all cases the evidence adduced was only circumstantial. During the last two years the writers have studied more closely some of the habits of these insects and their relation to certain fungus diseases. The data here presented positively convict them of disseminating one parasitic fungus, *Leptosphaeria coniothyrium*, and strongly suggest the possibility of their carrying others.

The present paper is to be considered as supplemental to Bulletin No. 388 and Technical Bulletin No. 42 of this Station rather than as a summary of these publications. Some of the things mentioned are not considered in detail when such observations have already been discussed in the previous writings.

It is impossible to consider here the work of the vast number of writers (9, 27) who have discussed the dissemination of human and animal diseases. It will be necessary to confine ourselves chiefly to the literature of the agricultural phase of the subject. In considering agents of the transmission of bacterial diseases of plants E. F. Smith (38, 39) states that man, domestic animals (through the agency of the dung heap), birds, insects, and worms may distribute the bacteria. Waite (46), Stewart (43), Jones (23), and Burrill (3) have proved that insects carry the bacterium causing the fire blight of fruit trees. Others who have made observations on this disease have associated many other insects as possible carriers. Brenner (2) and Smith (38) have observed that aphides and the larvæ of the cabbage butterfly may disseminate the bacterium causing the black-rot of cabbage. Smith (37) has shown that the striped cucumber beetle (*Diabrotica vittata*) disseminates the organism causing the wilt of cucurbits; and, recently, Rand (33) has demonstrated that these insects may carry the disease over winter. Küster (24), working with pathogenic bacteria, has shown experimentally that bacteria remain at least 24 hours in the intestinal tract of cockroaches. He was able to find some of the bacteria in the excrement a month after the insects were fed cultures. These organisms were still viable, and without any effect upon the insect. Wheeler (48) suggests that ants may disseminate the fire blight of fruit trees because they feed on the liquid, saccharin excrement (honeydew)

of sucking insects such as plant lice, scale insects, psyllids, cicadas, etc., which may have fed previously on diseased tissue.

Considering the fact that insects normally act as carriers of pollen, it appears but natural that smaller organisms such as fungus spores could be carried with greater ease. Heald (18) and Stewart and Hodgkiss (42) found a mite associated with the bud-rot of carnations. Grossenbacher and Duggar (17) noticed that the American currant borer, *Psenocerus supernotatus*, fed on the sclerotia and stromata of *Botryosphaeria ribis*, and that in some cases infection had taken place about some of the oviposition punctures. Clinton (5) and Burrill (4) have shown that the fungus of the apple bitter-rot is carried by insects. Ducloux (10) believes that the woolly aphis is the cause of the distribution of the European canker fungus, *Nectria ditissima*.

The dissemination of the chestnut bark disease has been much considered by recent writers. Heald ,and Studhalter (19) have shown that birds may carry the causal organism. Studhalter (44) and Studhalter and Ruggles (45) ascertained the number of Endothia or other spores found on the bodies of ants and other insects, and have shown that these spores may become dislodged by the movements of the insects. Craighead (8) observed that certain insects, especially *Leptostylus macula*, eat the pustules and stromata of *Endothia parasitica*. He made plate cultures of the stomach contents and excrement of this species but failed to obtain growth of Endothia. Because of this fact he concluded that the insect plays an important role in checking the chestnut bark disease.

Whether or not the spores of fungi are acted upon by the digestive juices in their passage through the intestinal tract of animals has often been discussed, but less often proven. *Ascobulus furfuraceus* (22) and *Onygena equina* (31) were found to germinate only after they had been acted upon by the digestive juices of animals. Honcamp and Zimmerman (20) while working on the passage of stinking smut through the digestive tract found that the spores were not viable after passing through chickens or other higher animals. Arzberger (1), in some of his unpublished work on corn, has shown that the spores of *Coniosporium gecevi* and *Fusarium* spp. found on the kernels of corn, would pass through the alimentary tract of chickens uninjured. In fact, spores had germinated and produced mycelium that readily grew on the culture medium. That insects are attracted to stinkhorns has long been known (since 1575) and that their spores are found in insect excrement was shown by Fulton (14). Cobb (7) showed that the spores of the stinkhorn, *Ithyphallus coralloides* (said to cause a root disease of the sugar cane), are eaten by flies, beetles, ants, cockroaches, earwigs, wood-lice or sow-bugs. Such spores passed through the digestive tract unchanged. On the other hand, the spores when eaten by a mule did not germinate, having apparently been acted upon by the digestive juices. Lewton-

Brain (25) also, working with sugar cane diseases, found that the red stem-rot due to *Colletotrichum falcatum*, usually enters through wounds made by the cane borer. Grassi (16) fed flies Lycopodium spores, *Oidium lactis* from cream, and the spores of Botrytis taken from silkworms. Both the Oidium and Botrytis were found in the flies' dejections. Mercier (26) found the excrement of *Sciara thomae* composed mostly of the spores of Claviceps. Wheeler (47) in discussing the fungus-growing ants of North America describes ants collecting caterpillar excrement and portions of leaves in order to make the so called "fungus gardens." He (48) also suggests that the ants may distribute spores by dropping hypopharyngeal pellets or by dropping their germ-laden feces. Petch (30) observed that the termites used their own excrement in making the fungus gardens and that on this material various species of fungi were usually found more or less constantly. The ambrosia beetles (47) are known to have fungi growing upon their feces and that these fungi are also used as food. Schneider and Orelli (36) found this fungus generally to be *Monilia candida*, and that the female *Xyleborus dispar* carries in her gizzard a supply of the spores which are not digested. Forbes (12) studied the feeding habits of tree crickets and noted that spores of various fungi could be found in their excrement.

Several species of Coniothyrium have been suspected of being carried by insects and higher animals. Prillieux (32) describes the white rot of the grape due to *C. diplodiella*, states that it is a wound parasite, and that it is found about injuries made by the Cochylis. Stewart and Eustace (41) observed lesions produced by *Coniothyrium fuckelii* about oviposition punctures made by the tree cricket* on raspberry canes. Clinton (6) found a fruit-rot of the raspberry due to this fungus, and states that the spores may have been carried by bees or insects that had previously crawled over stems coated with spores. Hopkins (21) noted a blighted or cankered area about tree-cricket punctures, but did not ascertain the cause. Parrott and Fulton (28) have called attention to *Leptosphaeria coniothyrium* as being present in such cankers and suggested that tree crickets were the possible carriers. Engler and Prantl (11) record *C. coprophilum* as occurring on rabbit dung in Argentina, indicating that this fungus may have entered the alimentary tract of the animal and was uninjured in the digestive processes.†

* Reported as snowy tree cricket, *Œcanthus niveus;* but, from the description of the manner of oviposition, evidently *Œ. nigricornis*.

† That fungi are carried in and develop on the dung of herbivorous animals has long been known. Fresh horse dung placed under proper conditions will develop many species of fungi that appear and disappear in rapid succession. Some fungi are to be found only on the dung of certain species of animals due to their peculiar feeding habits. This subject has been considered by many writers amongst whom are Brefeld (Unters. Gesammtgeb. Mycol. 14: 29, 1908), Arthur (Ind. Sta. Rpt. 1899, p. 125), Morse (*Phytopath* 2: 147, 1912), Massee and Salmon (*Ann. Bot.* 15:313-357. 1901), and Buller (Researches on fungi, pp. 224-230. 1909).

DESCRIPTION OF TREE-CRICKET CANKERS.

The prevalence of the cankers formed by *Leptosphaeria coniothyrium* (Fckl.) Sacc. (*Coniothyrium fuckelii* Sacc.) has been generally overlooked in the orchard due to the fact that they are seldom recognized as such. More often they are mistaken for the early stages of other cankers such as those caused by *Bacillus amylovorus* (Burr.) De Toni, *Sphaeropsis malorum* Pk., or *Glomerella cingulata* (Stonem.) S. & v. S. Previous writers at this Station (28, 13) have described the interesting egg-laying habits of the various species of the tree crickets. From the latter part of August until the insects are killed by frost, the females deposit their eggs in the various host plants. As *Œcanthus niveus* De Geer and *Œ. angustipennis* Fitch are of economic importance to apple trees these species were given special study with reference to their ability to carry fungi. The essential difference between these two species, insofar as dissemination of diseases is concerned, lies in the fact that the former plugs the opening of the oviposition puncture with a pellet of excrement, while the latter uses portions of chewed bark that it has gathered promiscuously. *Angustipennis* prefers branches one-third to one-half inch in diameter while *niveus* generally selects succulent branches from one to three inches in diameter. *Œ. exclamationis* Davis also uses a pellet of excrement, and it is believed that this species, although much less common and localized in its distribution, may also be a disseminator of plant diseases.

If, in the fall, before the leaves drop, one examines the tree-cricket punctures made on apple trees, the early stages of this canker may be found. The slightly-sunken, circular or elliptical areas of bark may be as large as 2.5 cm. (one inch) in diameter with the oviposition puncture in the center or slightly below the center. When first attacked the bark becomes water soaked and, upon drying slightly, turns brownish in color. Upon complete desiccation the color changes to a dull red. The parasite not only kills the bark but invades the underlying wood and gives it a brown color. The desiccation of the diseased bark, combined with continued growth of the healthy bark, produces a line of demarcation between these tissues. In the warm days preceding the blooming period these cankers may enlarge or new ones which had not shown any activity before may become aggressive. Usually, this period is more favorable for the development of the natural cankers than the fall of the year. Plate XIV, fig. 1, shows Leptosphaeria cankers about oviposition punctures. In this case the punctures were covered with grafting wax as soon as made. The cankers enlarge by degrees through periods of growth alternating with periods of quiescence. This results in the formation of rings of light- and dark-colored bark. In some cases eight or nine such rings have been observed. Plate XIV, fig. 2, is the upper canker

shown in Fig. 1 with the grafting wax removed. It shows a newly-formed ring of secondary growth which has not changed color and no crack has formed between the first and second periods of fungus activity. In the Spring the cankers may be as much as 7.5 cm. (3 inches) in length or may be merely a puncture with some dead tissue about it. Sections made through a puncture and the surrounding dead tissue will show strands of mycelium passing from the excrement to the tissue. Cultures have been made of the cankered bark and from the tissue about the punctures which showed but little disease, and the Coniothyrium was readily isolated. Saprophytes, also, are found in these tissues, but these are considered as secondary, having attacked the tissue after it was killed by the parasite. In this bulletin we have considered all lesions larger than 5 mm. ($\frac{3}{16}$ of an inch) as produced by the organism while those smaller than this are attributed to mechanical injury made by the insect's ovipositor.

There is always a tendency on the part of the host to exclude the parasite by the production of a callus at the boundary between the healthy and diseased bark. This may consist, in some cases, of a few bark parenchyma cells formed at right angles to the line of fungus attack. The parasite is unable to attack the growing tissue and in some seasons the entire wound may be healed. Often the callus tends to pry the dead bark loose from the wood, thus producing a concave dead area of bark. Usually this bark is separated from the wood and is held in position at the margin by fragments of bark. In but few cases does the fungus again become aggressive in the autumn after a callus has formed; but when this happens the callus is killed back and concentric rings of dead tissue resembling miniature Nectria cankers are formed. Plate XV, fig. 1, shows a tree-cricket canker that made a growth in the autumn of 1915. Fig. 2 is a longitudinal section of the same. The wood beneath the bark lesion is dark brown in color with tissue strands of still darker color in the 1914 wood. Mycelium of the parasite was seen in this wood and portions of the wood transferred to culture media gave rise to the pycnidial stage of *Leptosphaeria coniothyrium.* These figures also show how the callus pries off the diseased bark, forming cavities in which woolly aphides and other insects like to hide.

In some cases the callus, in the healing process, tends to bunch at the center of the wound. This tender tissue, when irritated by the presence of the woolly aphides, may produce outgrowths called flap tumors by Reed and Crabill (34). The largest outgrowth of this kind observed in the orchards about Geneva was 6 mm. (one-fourth inch) in diameter and was produced in 1915 from the center of a healed canker estimated to be more than three years old. Upon this dome-shaped outgrowth, as well as on other smaller ones, woolly aphides were found. It is believed that the flap tumor, as described by Reed and Crabill, is not due to the tree crickets or the parasite

Coniothyrium; but that the woolly aphides, by their presence, stimulate the growth of the tissues in the same manner as in the formation of galls produced on roots on branches infested by this insect.

An examination of the cankers a year after the punctures were made by the insects will show but few fungus fruit-bodies developed. In some cases, especially on the large cankers, the pycnidial form, *Coniothyrium fuckelii*, may be found as black dots in a gray-tan background of dead bark at the edge of the lesion. In other cases, the papery epidermis may become loosened and expose the pycnidia resting on the bark. Should the bark have become sloughed off early in the summer the pycnidia may be found resting on the surface of the wood. On the loose bark which has been dead for two or more years the pycnidia can be readily seen hidden underneath the epidermis and resting upon the surface of the bark. When moistened with water these can be seen even with the naked eye. On such tissue, *Sphaeropsis malorum*, *Valsa leucostoma* or lesser parasites, and saprophytes also, can be found. In some orchards the superficial form of Sphaeropsis canker may be found on the larger apple branches about the tree-cricket punctures. These areas are from 5 to 10 cm. (2 to 4 inches) in diameter and differ from the Leptosphaeria cankers in that in the former only the outer layers of bark are attacked.

On young trees of *Ulmus americana* 10 to 12.5 cm. (4 to 5 inches) in diameter, and growing among tall weeds, *Coniothyrium fuckelii* was found producing superficial cankers about the oviposition punctures. Associated with this fungus was found *Pestalozzia insidens* (49). On older trees, grown in a nearby pasture, cankers were not found.

As the canker caused by *Leptosphaeria coniothyrium* is so often found associated with tree-cricket punctures it is proposed that the common name tree-cricket canker be applied to it. It is admitted by the writers that this insect is capable of carrying, also, other canker-forming fungi, but the cankers produced by them can be readily distinguished from the Leptosphaeria cankers. Moreover, they are of infrequent occurrence.

Considering the general habits of the tree crickets, there are several possible ways in which the spores of fungi may gain entrance to oviposition wounds and, later, form cankers. Spores may be inintroduced: (1) With excrement used in plugging the punctures; (2) with chewed vegetable tissue used in plugging the punctures; (3) on the ovipositor; (4) by being washed into the punctures by rain. These different methods will now be considered in detail.

PASSAGE OF FUNGI THROUGH THE DIGESTIVE TRACT OF TREE CRICKETS.

If bacteria or fungi are still viable after passage through insects, this fact in itself would indicate that the insects are disseminators

of diseases. Before making feeding tests it was thought advisable first to ascertain what organisms are found in the excreta of the tree crickets found in the field. The nature of the excreta naturally depends upon the material that the insect eats. Forbes (12) states that the food of Œcanthus is highly miscellaneous, consisting largely of floral organs of grasses and other plants, pollen, leaf tissue, various fungi, plant lice and other insects. To this list may be added dead leaves, diseased bark, and fruit such as pears, peaches, plums, etc. In order to obtain excrement, 100 tree crickets were captured in a somewhat neglected orchard and placed in a clean cage for 24 hours. No food was given them during this period. Excrement was also collected from the openings of oviposition punctures. In some cases the feces were forced from the body and collected under sterile conditions. These pellets were examined under the microscope and in no case were any found free from fungus spores or mycelium. Spores of all sizes and descriptions were found, most of which it was impossible to classify. Besides numerous bacteria and yeasts, there were fungus spores which might belong to the following genera: Penicillium, Aspergillus, Mucor, Phoma, Cladosporium, Fusicladium, Cephalothecium, Pestalozzia, Fusarium, Septoria, Ascochyta, Sphaeropsis, Coniothyrium, Coryneum, Puccinia (uredo and teleutospores of *P. graminis*), Oidium, Fumago, etc. The spores and adults of *Gregarina* sp., an intestinal protozoan, were also very common. Many of the fungus spores germinated when placed in drops of water and kept in a damp chamber. Poured-plate cultures were made of the pellets, but in most cases the medium was soon overrun with the more rapid-growing fungi. That *Sphaeropsis malorum* may also be found in the excrement is seen in that six out of eight pellets examined on one occasion showed these spores present and, when plated out, colonies of this fungus were recognized.

Preliminary feeding tests were made to determine if spores will pass through the digestive tract uninjured. For this purpose 14 feeding experiments were made with three tree crickets in each experiment. One of these tests has already been reported (29). The insects were placed in cages and permitted to feed on raspberry leaves which had been sprayed with a 2 to 5 per ct. sugar solution containing spores of corn smut (*Ustilago zeae*), or spores of a mushroom (*Coprinus micaceus*). The tree crickets were observed for several days, and the excrement collected and placed in drops of water. In no way was the germination of the spores impaired in going through the digestive tract, the percentage of germination being the same as in the checks.

The preliminary experiments having proved satisfactory, it was thought advisable to ascertain if the various fungi causing apple-tree cankers would pass through the digestive tract uninjured. For this purpose a single tree cricket (*niveus*) was chosen. It was placed under a soil percolator which was properly ventilated, and fed upon

a ripe pear (variety Vermont Beauty). It was allowed to feed also on the following fungi, only one being present at a time: (1) A stroma of *Nummularia discreta* and its surrounding bark, upon whose surface there were estimated to be from three to five million spores*; (2) a dead branch of an apple tree bearing a large number of pycnidia of *Sphaeropsis malorum;* (3) a portion of a Cuthbert raspberry cane attacked by *Coniothyrium fuckelii,* the spores of which were so plentiful as to give the cane a dusty brown coating. In order to provide drink for the insects and facilitate mastication the portions of diseased tissue were moistened with water every other day.

The test was carried on from October 28 to November 25, 1915, and in no case was the germination of the spores affected in any manner. From six to twelve pellets of gray-black excrement measuring 1.5 x .75 mm. are given off in 24 hours. Tree crickets starved for 40 hours and then fed spores showed these same spores in the excrement within 6½ hours. Generally, the spores remain at least 24 hours in the digestive tract. It was observed that when the branches were moistened with water very few pellets were collected the following day. Instead, the wall of the glass soil percolator was spattered with soft pellets ejected by the insect. In one case the excreta were thrown 7 cm. (2¾ inches) from the branch and on a level with the top of the branch. In other cases pellets were found 7.5 cm. (3 inches) from the nearest portion of the branch and 17.5 cm. (7 inches) from the top of the branch from which point they were ejected. This would indicate that in some conditions the excrement is not under control of the insect. Under such conditions few plugs would be found in the oviposition punctures.

The feeding experiments made with *Nummularia discreta* showed some interesting facts. A drop of water was placed on the stroma to induce the insect to drink. The cricket was seen to walk through this liquid, and soon thereafter preen its legs with its mouth-parts. Only after 44 hours were a few pellets collected that showed 10 to 15 spores that had been taken into the digestive tract during the preening. After 8 days the insect finally found the spores on the stroma and made a good meal of them. An examination of the stroma showed but few spores where previously there were millions. The pellets collected the next day were black and made up mostly of spores. Five days later the last of these spores were expelled by the insect. Pellets, made up mostly of spores, showed in one case about 2 per ct. of the spores chewed while in other pellets none were observed to be ruptured. Pellets, as well as spores taken from a stroma, were placed in drops of water to compare the germination. In both cases there was a retarded and low percentage

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* Based on counts made by a hemacytometer on similar stromata.

(2 per ct.) of germination. The experiment was then repeated, with a few hand sections of apple wood placed in some of the drops of water. The spores became attached to the wood sections and those from both the pellets and checks showed a rapid germination of over 95 per ct. in 24 hours. Those placed in distilled and tap water again showed the low percentage of germination. These tests were repeated many times (using vials as well as drops of water), and it was established that in the fall of the year the spores of *N. discreta* readily germinate in the presence of apple wood and that these spores pass uninjured through the intestinal tract of the tree cricket.

When apple branches bearing Sphaeropsis or raspberry canes bearing Coniothyrium were used in the feeding tests the same general results were noted. On the apple branch the tree cricket would chew the pycnidium of *S. malorum* as well as the surrounding bark producing a cavity as large as a pin head. The papery epidermis of the raspberry canes was also eaten. As the insect has a tendency to climb as high as it can, these chewed portions of the bark were most often observed near the tops of the canes or branches. The first spores of *S. malorum* found in the pellets were few and did not germinate even when placed in the presence of sections of apple wood. Later, spores were more abundant; also pycnidial tissue from which mycelium would grow. These later spores germinated readily in water, and quite as well in the absence of wood sections as in their presence. The spores of *Coniothyrium fuckelii* were readily eaten and were plentiful in the excrement. In water, the spores from the pellets and also those taken directly from the canes germinated slowly, producing short hyphæ. When placed in the presence of sections of apple wood the percentage of germination increased from 25 to 100 per ct., and the growth of mycelium was five to six times as rapid. Spores of *Sphaerella rubina* also passed through the digestive tract uninjured.

Since the tree cricket used in the above experiments lived about a month on a diet of pear and diseased apple bark and raspberry canes it may be of interest to consider the source of its nutrition. It is clear that no nourishment was obtained in eating the spores, for they were not digested. Perhaps some of the bark eaten was predigested by the fungi; but this would not explain why the large mass of Nummularia spores was eaten. It is possible that the spores may act as roughage and were eaten for that purpose; but it appears more plausible that the spores still retain on their surface some of the protoplasm of the ascus or pycnidium which makes them palatable. In some pellets most of the material was made up of spores, mycelium or bark, while in others the greater portion consisted of digested pear tissue. In the pear, the insect would first chew holes about 2 mm. in diameter — just large enough to permit the entrance of its head. In subsequent feedings the holes would

be enlarged. It was observed that the insect rejected small portions of pear tissue .5 to .8 mm. in size. Upon examination these were found to consist mostly of stone cells. However, all of the stone cells were not rejected as being too hard to chew for some were also found in the dejections. That the toughness of the skin of the fruit is important in resisting the insect is shown by the fact that when tough-skinned grapes or apples were placed in the cage they were not attacked. These observations confirm those made by Garman (15) who noted that tree crickets rather than bees injure plums, peaches and grapes. About the holes made on the pear, decay would set in and Penicillium, Alternaria, *Sphaeropsis malorum* and *Coniothyrium fuckelii* were found, indicating that spores of these fungi may have been distributed through the mouth-parts of the insect or carried on its body and deposited on the injured tissue.

That *Œ. nigricornis* may disseminate fungi can be seen in the examination of its oviposition punctures made on raspberry. Hard sections of the tissues about these wounds showed the presence of ramifying strands of mycelium arising from the masses of chewed tissue inserted into the holes. In this manner may be explained the numerous lesions of cane blight that develop about tree-cricket punctures on raspberry canes.

After the death of the specimen of *niveus* used in the above experiments, it was dismembered and the portions examined under the microscope. As the insect was last feeding on a branch attacked by *Sphaeropsis malorum* it was covered with the dark-colored Sphaeropsis spores which could be readily seen and counted. On the hind legs were counted 456 spores of which the greater number were found at the proximal end of the tarsus near the tibial spurs, which assist the insect in clinging to the bark. Plate XVII, fig. 1, is a photomicrograph of the tarsus showing the numerous spores clinging to the spurs, hairs and surface of the leg. On the second pair, and on the fore legs, 87 and 18 spores respectively were counted. On the head, mouth-parts and antennae, 30 spores; on the dorsal and ventral surfaces of the body 25 spores; and on the wings 39 spores were counted, making a total of 655 Sphaeropsis spores found on the tree cricket. Six Nummularia spores were found — two on the wings and four on the tibia of one of the hind legs. As the insect had not been in contact with the spores of this fungus for 20 days this further demonstrates how long the spores may cling to the body of these insects. The small size of the Coniothyrium spores and their similarity in color to that of the insect made it difficult, by direct observation, to obtain data in regard to the number of spores present. In examining the wings we were surprised to find germinated spores of unidentified fungi which had gotten on the wings before the insect was introduced into the feeding cage. Plate XVII, figs. 2 and 3, are photomicrographs of portions of the wings. Figure 2 shows the mycelium arising from a portion of dead bark,

and on one side are seen Sphaeropsis spores that had not germinated. In Fig. 3 the mycelium arose from some spiny spores of an unidentified fungus. In general, those portions of the body most difficult to preen had the most spores on their surfaces, and it appears evident that the insect can disseminate fungus spores not only by means of its excrement, but also by dropping spores that become attached to its body.

ATTEMPTS TO INDUCE CANKER FORMATION BY MEANS OF THE EXCREMENT.

The evidence that spores pass through the digestive tract of the tree cricket uninjured, a fact in itself sufficient to convict the insect of being a disseminator of diseases, led the writers to inquire if, under controlled conditions, apple cankers could be formed by them. For this purpose a large number of tree crickets were collected in 1914, placed in cages and allowed to feed on raspberry leaves, which they readily ate. Mycelium from pure cultures of *Coniothyrium fuckelii*, isolated from an apple canker, was ground in a sterile mortar, placed in prune juice, 2 per ct. sugar solution or in distilled water, and then spread upon the raspberry leaves. In other cages, were placed raspberry canes infested with *Coniothyrium fuckelii* showing an abundance of the pycnospores, and the insects allowed to feed on them for at least 24 hours. The two species, *Œ. niveus* and *angustipennis*, were then separated and placed in cages about apple branches.* For *niveus*, branches at least 2 cm. (¾ inch) in diameter were selected while for *angustipennis* smaller branches were used. These tests were begun September 9, and ended October 13, when the cold weather made it impracticable to continue them longer.

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* The cages used in these experiments proved highly satisfactory. They are made in the following manner: Stretch tightly two parallel wires A and B, 21 inches long and ten inches apart. Commencing three inches from one end of these wires, lay across them, at intervals of five inches, three pieces of wire 22 inches long and one piece, C, 30 inches long. Let the long wire project about four inches beyond the shorter ones at each end. At the points of intersection fasten the cross-wires securely to A and B. This is best done by means of U-shaped pieces of wire which are first placed astride the cross-wire, then bent under the intersecting wire and upward on the opposite side where the ends are finally twisted together over the cross-wire. In making the fastening, both wires must be bent a little to prevent slipping. If the wire used is not too coarse this is readily accomplished by twisting the ends of the fastener with a pair of pliers. Iron wire, No. 12 gage, is very satisfactory for this purpose. Up to this point the construction resembles closely that of a small wire fence. Time may be economized by making several frames at one time on two long pieces of wire.

The frame is now ready to attach to the branch. Place the long wire, C, parallel with the branch. Bend the wires A and B around the branch in such a manner as to make a four-sided figure and fasten together their free ends by means of a hook-and-eye attachment. At the upper and lower ends of the frame bend inward the free ends of the three shorter wires, place a ring of cotton between them and the branch, and fasten all securely to the branch by winding closely around them the projecting ends of the long wire C. (See Plate XVI.) Over this frame wrap cheesecloth closely and tie the ends above and below with string.

The insects are introduced just before tying the upper end.

It was observed that when the insects were caged on the branches for two nights the weaker ones (usually males) were killed and partly eaten by their stronger companions. The mortality being high it was decided to supply them with aphides (several species) found on weeds and grain. After this was done but few crickets were killed. At the end of the second day the cages were examined and the number of punctures counted. Some of them were covered with grafting wax, to exclude outside contamination, while others were left untreated, but their position was marked with white lead paint. This last method was necessary in order to distinguish cankers formed under controlled conditions from those that might be formed later in the natural manner. The growth of the cankers was observed from time to time the final examination being made November 18, 1915. The results, as given in Table I, include all cankers larger than 5 mm. ($\frac{3}{16}$ inch) in diameter. Cultures were not made of all of the cankers formed, but whenever such cultures were made (especially in the early stages) no difficulty was found in obtaining the Coniothyrium. Other fungi (saprophytes) were also found, but they were not constant.

TABLE I.—SUMMARY OF DATA PERTAINING TO CANKERS FORMED ABOUT THE OVIPOSITION PUNCTURES OF TREE CRICKETS KEPT UNDER CONTROLLED CONDITIONS.

Number of cages.	Species of tree cricket	Number of punctures made.	Treatment of punctures.	Total number of cankers formed.	Percentage of cankers formed.
	Fed pure cultures of *C. fuckelii* from apple canker.				
17	*Œcanthus angustipennis*.....	118	Waxed...	9	7.6
23	"	210	Unwaxed.	4	1.9
4	"	0	....	0	0
31	*Œ. niveus*................	275	Waxed...	17	6.1
37	"	414	Unwaxed.	8	1.9
6	"	0	....	0	0
	Fed raspberry canes infested with *C. fuckelii*.				
13	*Œ. angustipennis*..........	118	Waxed...	24	20.3
6	"	59	Unwaxed.	5	8.4
5	"	0	....	0	0
19	*Œ. niveus*................	177	Waxed...	44	24.8
6	"	62	Unwaxed.	11	17.3
2	"	0	....	0	0
	Checks: fed raspberry leaves only.				
3	*Œ. angustipennis*..........	10	Waxed...	0	0
1	"	3	Unwaxed.	0	0
2	"	0	....	0	0
11	*Œ. niveus*................	97	Waxed...	3	3.
11	"	88	Unwaxed.	0	0
5	"	0	....	0	0
202		1,631	....	125	7.6

Experiments were made to determine if cankers would form when the crickets were eliminated thus removing the possibility of infection from spores carried on their bodies. For this purpose pellets of excrement were collected from the feeding cages, and inserted into apple branches using the usual precautions to keep the tissues and instruments sterile. The wound was made by punching a hole in the bark with a sterile forceps thus imitating, in a way, the oviposition process. Into the wound a pellet was inserted and then covered with warm grafting wax. It was found that the wax would not readily adhere, due to a copious flow of sap. In most cases sufficient sap would be present to soften the pellet and disintegrate it; but upon drying it would reform as a neat cap covering the opening of the wound. On succulent branches enough sap would exude to wash all the excrement from the wound. In the early part of the egg-laying season pellets are often seen as eliptical masses forced into the punctures. Subsequently, caps form over the wounds, indicating that the exudation of sap may take place later when the condition of the host is more favorable for the process. Under ordinary conditions the insect (*niveus*) may be seen packing the excrement in position, but it may be assisted by the softening of the excrement by the sap. In the Spring of the year when the Leptosphaeria is about to become active, and continuing for some time, a brown, sweet, sap may be observed exuding from the oviposition punctures or from the cankers formed in the preceding Autumn. The results of attempts to form cankers with the insects eliminated are summarized in Table II. The experiments were made at the end of the egg-laying season, and the excrement used was that which had accumulated in the feeding cages for various periods, the number of days being indicated by figures in the column under "age of excrement" in Table II.

TABLE II.— SUMMARY OF DATA FROM EXPERIMENTS ON THE PRODUCTION OF CANKER BY ARTIFICIAL INOCULATION OF APPLE BRANCHES WITH TREE-CRICKET EXCREMENT.

DATE.	Number of punctures.	Age of excrement (days).	Number of cankers formed.	Percentage of cankers formed.
Fed raspberry canes infested with *C. fuckelii.*				
Oct. 22	39	5	5	13
Nov. 2	29	8	2	7
Nov. 2	183	30	5	3
Checks: fed raspberry leaves only.				
Nov. 2	22	5	0	0
Checks: punctures only.				
Nov. 2	77	0	0	0

EXPLANATION OF PLATES.

PLATE XIV.— FIG. 1. Cankers about oviposition punctures of *Œcanthus niveus* on an apple branch. Tree crickets were permitted to feed on raspberry canes infested with *Coniothyrium fuckelii* and then caged on an apple branch during two nights. Seventeen oviposition punctures were made each of which was covered with grafting wax. Four cankers, *a*, *b*, *c*, *d*, were formed. From *a* and *d* pure cultures of *Coniothyrium fuckelii* were obtained; while *b* gave rise to rapid-growing saprophytes which overran the slower-growing Coniothyrium. Cultures of *c* remained sterile owing to too long treatment of the tissue with mercury bichlorid. Natural size.

FIG. 2. Canker *a* of *fig. 1* twice enlarged. The grafting wax has been removed to show the relation of the puncture to the canker. This figure shows, also, the zonation of the dead tissues due to periods of varying activity of the fungus. The second zone was formed five days after the first. It was characterized by a slight reddening of the bark while the color of the older or central portion of the canker was reddish brown.

PLATE XV.— FIG 1. Canker formed about an oviposition puncture of *Œcanthus niveus* on an apple branch. Tree crickets were permitted to feed on raspberry canes infested with *Coniothyrium fuckelii* then caged on a Baldwin apple branch September 29, 1914. The oviposition punctures were not covered with grafting wax, but their location was marked by dabs of white paint. Eighteen punctures were made, but only one canker resulted. This canker, not in evidence as late as April 3, 1915, had attained a diameter of 2.5 cm. (one inch) by May 8, 1915. During the following summer a callus formed and the growth of the canker was arrested; but in the autumn of 1915 the fungus again became aggressive and produced an enlargement of the lesion at the upper end. The oviposition puncture from which the canker originated may be seen a few millimeters below the paint spot. Enlarged one and one-half diameters.

FIG. 2. A longitudal section through the canker shown in fig. 1. Microscopic examination of the discolored (brown) wood revealed the presence of fungus hyphae in it. Cultures were made and *Coniothyrium fuckelii* obtained. This figure shows how the formation of the callus causes the dead bark to separate from the wood. In the newer portion (upper part) of the canker the bark is dead but the wood underneath is not yet discolored. Enlarged one and one-half diameters.

PLATE XVI.— Frame of cage for confining tree crickets on apple branches. For description see footnote on page 14. About one-fourth natural size.

PLATE XVII.— FIG. 1. Photomicrograph of the proximal portion of the tarsus of a hind leg of *Œ. niveus* showing spores of *Sphaeropsis malorum* clinging to spurs, hairs and surface of the leg. The spurs serve as holdfasts to assist the tree cricket in walking on upright surfaces.

FIG. 2. Photomicrograph of a mass of mycelium found on the wing of *Œ. niveus*. Spores of *Sphaeropsis malorum*, although present, have not germinated.

FIG. 3. Photomicrograph of germinated spores on the wings of *Œ. niveus*. In this case the spores (unidentified) are large and spiny. They became attached to the wings while the insect was in the field.

PLATE XIV.— TREE-CRICKET CANKERS ON APPLE BRANCHES.

PLATE XV.— CANKER AROUND OVIPOSITION PUNCTURE OF A TREE CRICKET ON AN APPLE BRANCH.

PLATE XVI.— FRAME OF CAGE FOR CONFINING TREE CRICKETS ON APPLE BRANCHES.

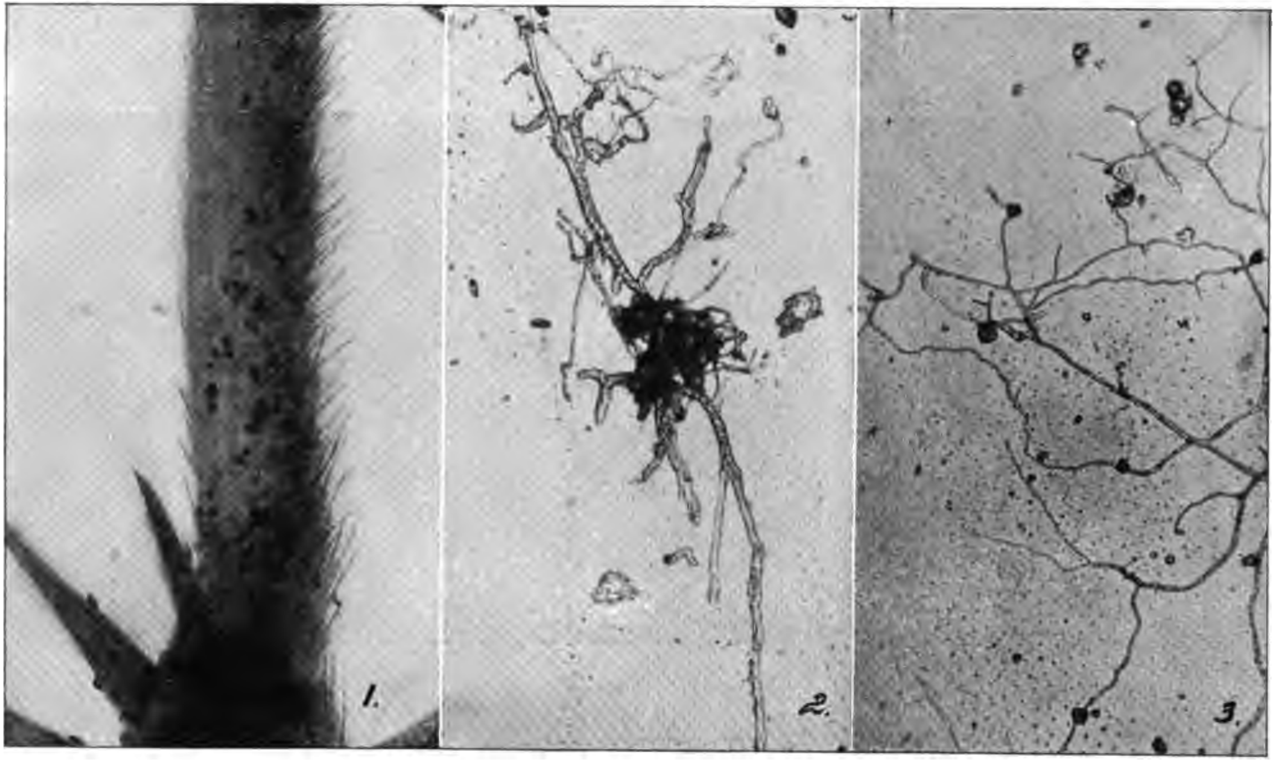

PLATE XVII.— FUNGUS SPORES AND MYCELIUM ON LEG AND WINGS OF A TREE CRICKET.

A few attempts were made to produce cankers about oviposition punctures by the use of other organisms. Tree crickets were allowed to feed on peaches attacked by the brown-rot fungus, *Sclerotinia fructigena*, and then were placed on peach trees. Oviposition punctures were made, but in all cases the egg, as well as the excrement, was forced out of the puncture by the formation of gum. Experiments were made, also, with tree crickets fed pure cultures of the fire blight organism, *Bacillus amylovorus*, but in all cases the results were negative. These experiments were made September 9, 1914, and the season was not favorable for the activity of the organism.* While under ordinary conditions it is hardly probable that the blight organism is disseminated by tree crickets, yet, under exceptional conditions, they may be a factor in spreading it.

The parasitism of *Leptosphaeria coniothyrium* has been proven by making inoculations with pure cultures isolated from various hosts. That *Coniothyrium fuckelii* is genetically related to *Leptosphaeria coniothyrium* was suggested by Saccardo (35) and later proven by Stewart (40). It may be stated that variations in virulence and cultural characters exist among the various strains of Coniothyrium isolated from different hosts; but as more time is required for the completion of our studies along this line the discussion of the subject will be reserved for a future publication.

PREVENTIVE MEASURES.

In considering methods for the control of tree crickets in apple orchards we have observed that the ordinary practices of spraying and cultivation will control the insects. Dormant sprays do not affect the hatching of the eggs. It is the sprays containing arsenical poisons that are effective. An examination of the bark from unsprayed trees will show it to be very much pitted; while the bark of trees of the same age but well sprayed will be smooth and free from tree-cricket scars. As the nymphs appear early in June it is likely that they are killed by the ordinary arsenical sprays applied at that time for codling moth.

DISCUSSION.

It has here been shown that the tree crickets not only carry fungus spores on their bodies, but that they eat mycelium and spores, which are unaffected by the intestinal juices. It may be supposed that since *Œ. niveus* plugs the oviposition puncture with excrement

* That *B. amylovorus* may be active in September has been observed by one of the writers. In 1911, at Wooster, O., an attempt was made to keep a 25-year-old Tolman apple tree free from blighted twigs and branches. The last pruning was made early in September. Then the attempt was abandoned, for blight continued to appear, killing the twigs. The season was a very moist one, and the epidemic was closely associated with an infestation of leaf hoppers.

every wound ought to have produced a canker. There are several factors that may reduce the percentage of cankers formed: (1) The organism necessary for the production of the canker may not be present in the particular pellet inserted into the puncture; (2) the insect may have been disturbed in the act of oviposition and the pellet not inserted into the puncture (often punctures were observed uncovered and in some cases the pellets were found clinging to the bark 2 to 3 mm. from the wound); (3) when the insect has access to an abundance of water the dejections may not be under the control of the insect and thus no pellet would be found in the puncture; (4) the germination of the spores may have been inhibited by desiccation of the pellet; or the exudation of the sap, which under the stimulating influence of the wood tissue makes the spores germinate, may not have taken place. (5) Slow-growing branches may not be favorable for the formation of cankers; (6) the temperature, combined with the dormant condition of the tree, may not have been favorable for the activity of the fungus. Judging from inoculations made at the same time that the crickets were placed on the trees, it appears that numbers 1, 2, 3 and 4 were the prime factors in reducing the percentage of the cankers formed. That desiccation is important is seen whenever the punctures were not covered with grafting wax, for in all cases the percentage was lower than when they were covered. It is believed that but few spores are washed into the punctures by the rain, for, if such were the case, a higher percentage of cankers would have been formed where the punctures were left uncovered. The feeding of aphides to the tree crickets, while they were in the cages about the trees, had no effect in increasing or decreasing the percentage of cankers formed. That more cankers were formed when the insects were permitted to feed on raspberry canes infested with *C. fuckelii* than when they were fed pure cultures of this same fungus isolated from an apple canker can be explained by the greater virulence of the former. Also, in the case of the former the spores eaten were more resistant to desiccation than was the mycelium eaten in the latter case. That freezing of the tissues is not necessary for the formation of the canker is shown by the results of inoculation experiments, and also by the fact that cankers developed in the greenhouse.

It has been shown that spores of *Sphaeropsis malorum*, the causal organism of black-rot canker, may be found in the excreta of tree crickets captured in orchards, and that such spores often produce superficial cankers. It is possible, though not proven, that tree crickets disseminate, also, other canker-producing fungi such as *Nummularia discreta*, *Myxosporium corticolum* and *Glomerella cingulata*. It is not believed that the insects prefer to eat the spores of one fungus more than those of another. The intimate relation existing betweem tree crickets and the canker induced by *Leptosphaeria coniothyrium* is the result of certain concomitant factors.

In the light of the data here presented the conclusions of certain other writers require corroboration. Because certain spores pass through the digestive tract of the tree cricket uninjured it does not necessarily follow that all kinds of spores and bacteria will do so nor does it follow that when eaten by other insects these same or other spores will not be injured. In each instance actual experiments must be made to determine these facts. Craighead (8) regards *Leptostylus macula* as being of assistance in destroying the chestnut blight fungus *Endothia parasitica* because spores of the fungus eaten by the insect failed to germinate in his experiments. However, this subject has not been considered in all of its phases. It would be well to have the germination tests repeated. That tree crickets carry the chestnut blight is not on record, but that they oviposit on the chestnut has been reported.

In conclusion, the writers offer the suggestion that the fungi found in the " fungus gardens " of ants and termites and on the food (*fromage*) of the ambrosia beetles occur there because of favorable conditions for their development; and that the insects, in utilizing the fungi for food, unwittingly disseminate the spores with their excrement.

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CORK, DROUTH SPOT AND RELATED DISEASES OF THE APPLE.*

A. J. MIX.

SUMMARY.

Two little-known apple diseases are found in the Champlain valley. These are perhaps only different types of the same disease, are non-parasitic in nature, and are apparently closely related to the well known fruit-pit or stippen disease. The names cork and drouth spot are proposed for them. Associated with the drouth spot are abnormal conditions of the twigs and foliage; it is proposed to call these drouth die-back, and drouth rosette.

Cork is also found in Ontario and in New South Wales. It affects chiefly the Fameuse variety. Apparently the drouth spot has occurred in Maine and Virginia; and a closely related trouble occurs in the Pacific Northwest. Rosette has been reported from Colorado, California and Idaho; and both the rosette and die-back from the irrigated sections of Washington and Oregon. In the Champlain valley certain orchards and even individual trees are more affected than others. It is only in these particular cases that the diseases assume economic importance.

Cork is evident in late June as dead brown spots beneath the skin of the fruit or around the core. The fruit is normal externally. Later the fruit becomes distorted and knobby, and brown corky areas are found scattered throughout the flesh. Drouth spot occurs in early June and fresh stages may develop throughout the summer if the weather continues dry. Superficial or sunken, irregular, dead, brown spots show in the skin of the fruit, and dead brown areas may occur in the flesh beneath. In late stages the apple becomes cracked and deformed. The internal spots of both diseases are in close proximity to branches of the vascular system, and superficial drouth spots often show a wavy pattern of wrinkles apparently marking the subepidermal vascular network.

Under the microscope these spots show cells with brown amorphous contents shrunken away from the walls. Sometimes the cells are collapsed.

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Die-back consists in the death of a portion of the twig from the tip backward. Beyond this a brown discoloration in the cambial region extends back into healthy wood. The dead twig may be replaced by a healthy lateral from the base; but often there is found near the base of the twig a rosette-like cluster of dwarfed, lanceolate leaves. This appearance and one in which a compact cluster of similarly dwarfed leaves crowns a long, bare twig have been included under the name rosette.

Field observations show that these diseases may occur on the best types of soil in the locality, under conditions of careful culture, and in young and vigorous trees. In certain cases a shallow soil seems connected with their development. They may appear, however, on deep soils of good physical condition. A condition of soil conducive to poor moisture supply seems connected with severe outbreaks. Drouth accompanied by high, dry winds seems to bring on a large amount of drouth spot and cork; a subsequent rainy period, as in 1915, causes them to disappear. In a rainy spring, as in 1916, some disease occurs in trees that have been previously affected, but the amount is inconsiderable and the period of development much shortened.

The initial stage of die-back is found on the season's growth in midsummer. The following spring this die-back and the accompanying rosette are very noticeable. Dry weather in late summer seems directly responsible for die-back of the season's growth. If a wet summer follows a dry spring, this die-back is practically absent, and there is evident recovery from its preliminary stages. No abnormal condition of the roots is necessary to the occurrence of die-back and rosette.

Since these diseases may appear, to a limited extent, in a rainy season, lack of soil moisture cannot be considered their sole cause. It is, however, the one predisposing factor. Other factors, yet unknown, may be operative.

Assuming that an insufficient moisture supply to the fruit, accompanied by great transpiration, may bring about these diseases, it is suggested that the exact method of their occurrence may be through the leaves robbing the fruit of water. Leaves have a higher cell-sap concentration than green fruits and can remove water from the fruits by the process of osmosis. Chandler has called attention to this fact, and demonstrated it with detached

twigs bearing fruits and leaves. Following Chandler's method fruits have been rapidly wilted, and then, by placing the twigs in water, caused to regain their original state of turgor. In many such fruits spots resembling those of drouth spot, and, occasionally, those of cork, were produced.

One experiment indicated that a reduction of the leaf surface of the tree during the critical period might prevent the drouth spot, but this is not suggested as a practical means of control.

The only control method which offers promise of results is one looking to conservation of soil moisture, and an even distribution of the moisture supply throughout the season. Clean cultivation is not sufficient. From certain suggestions of benefit in the Champlain valley, and from results secured in the Pacific Northwest, clean cultivation followed by a leguminous cover crop, or the planting of a leguminous crop such as alfalfa in the orchard, seem methods which should be tried. Certain growers in the Champlain valley are testing them.

INTRODUCTION.

During the summer seasons of the years 1913-1916, inclusive, the writer had opportunity to observe two little-known apple diseases. The observations were made in Clinton County, New York, in the apple-growing section of the Champlain valley.

These two diseases are believed to be essentially the same, and closely related to the common apple disease known as fruit-pit, bitter-pit, or stippen. They have been called cork and drouth spot respectively. Cork is a name which has been applied locally for a number of years; drouth spot has been selected as a name indicating the probable cause. Two disorders of the twigs and foliage associated with the drouth spot have been called drouth die-back and drouth rosette.

VARIETIES AFFECTED.

Cork affects chiefly the Fameuse variety, although it sometimes occurs in Northern Spy, and has been found, rarely, in Oldenburg and Ben Davis. Drouth spot has been observed by the writer on the following varieties: McIntosh, Northern Spy, Ben Davis, Esopus, Bellflower, Maiden Blush, Wolf River, Wealthy, Baldwin, Jonathan and two unidentified varieties. The only variety of commercial

importance in the Champlain valley not included in the above list is Rhode Island. The disease has never been observed on Tolman, but this variety is less extensively grown.

HISTORY AND DISTRIBUTION.

Cork has apparently been known locally for at least fifty years. There is, however, little mention of it in literature, at least in a way which would allow it to be distinguished from the true fruit-pit or stippen. Craig (8) notes Fameuse as susceptible to stippen or "dry rot," as he terms it, and from the description by Selby (21) of specimens of Fameuse which he had received from Craig it is apparent that here was a case of typical cork. Selby (22), in a discussion of "brown spot" or "dry rot" of Baldwin, mentions internal spotting as occurring without external lesions in the varieties Fameuse and Northern Spy. Cobb (7) describes an "obscure disease" of the apple occurring in New South Wales. McAlpine (13) states that he visited this locality in the season of 1912 and found the same disease in various orchards. It was confined to the variety Pomme de Neige (Fameuse). The same author (14) again mentions this disease, stating that it is a type of bitter-pit occurring when the apples are very small, the irregular knotty appearance being due to subsequent growth. His figures, as well as those of Cobb, show that the "obscure disease" is identical with the cork of Fameuse as found in the Champlain valley.

Drouth spot, so far as is known to the writer, had not been mentioned in literature prior to his first observations in Clinton county. Specimens were submitted in 1913 and again in 1914 to Dr. Charles Brooks, of the Bureau of Plant Industry, and in 1914 Dr. Brooks visited Clinton county and went over the situation with the writer. He stated that he had never observed the trouble, although he had seen somewhat similar troubles in the irrigated sections of the Pacific Northwest. Dr. W. J. Morse, of the Maine Agricultural Experiment Station, who saw specimens of the disease in July, 1914, expressed the opinion that he had seen apples similarly affected in Maine. Recently, Reed and Crabill (20) have described a "skin crack" of the York Imperial in Virginia. The writer is convinced that this was a case of drouth spot that was not observed until in a late stage ("early in September"). It is mentioned as prevalent in 1914 and as having been noticed previously only in

very dry seasons. Brooks and Fisher (3), under the heading " corky pit or drouth spot," describe an apple disease occurring in the Northwest which, if not identical with the drouth spot, is at least very similar to it. They also state: " There is another form of corky pit that occurs on shallow soils in some sections of the East and West. It is common where there is a hardpan at a slight depth and also where there are peculiar soils outcropping. This disease is quite generally associated with rosette." The writer believes that the trouble occurring in Clinton County is referred to in the above statement.

Allen (1), in a report on the study of the root condition of apple trees in the Hood River valley, makes the following statement: "Some trees were found to be so seriously devitalized by drouth and starvation that the fruit was not only badly pitted but hollow in places. On such trees the foliage was very small; a large portion of it had fallen; and the ends of many twigs had begun to die back." The illustration of a pitted apple accompanying this article is more suggestive of certain severe types of drouth spot than it is of true fruit-pit or stippen. Also, it seems probable that the die-back here referred to may be the drouth die-back occurring in the East.

Apple tree rosette was first described by Paddock (19) from Colorado in 1902. Apparently, the same trouble had been noticed in California by Loughridge (12), where the cause assigned was an excess of alkali in the soil. Paddock presented evidence against this cause and ascribed the trouble to winter injury. Judson (11) states that, in 1903, apple rosette occurred in several parts of Idaho. It failed to appear on whip grafts made from affected trees. Henderson (10) describes the same trouble in Idaho under the heading " apple twig blight."

Rosette occurs in Washington and some work is apparently being done on the problem, for Cardiff (4) reports progress up to 1915 on " winter desiccation of fruit trees," or rosette. Photographs of trees affected with rosette accompany this article. The trouble is said to be independent of an excess of soil alkali, and to exist only in soils in which the humus content is very low. It is not transmitted by grafting from diseased onto healthy wood.

Clawson (6) says: " Rosette has caused a great loss to the orchardist of this [Wenatchee, Washington] as well as other districts of the Northwest."

Unfortunately, from the little that has been published regarding the rosette of the Pacific Northwest it is impossible to say positively that it is the same as that occurring in association with the drouth spot of the Champlain valley; but from conversation with Dr. Charles Brooks, of the Bureau of Plant Industry, who has seen both troubles, and from the examination of Cardiff's figures, and of photographs submitted to the Department of Plant Pathology at Cornell University by O. M. Morris, Horticulturist of the Washington State Experiment Station, the writer believes that they are identical.

How long the drouth spot has been known in the Champlain valley is uncertain. In 1913 two growers stated that they had observed a few apples affected with the disease about six years before and at various times since. A third grower stated that the trouble had occurred in his orchard several years previously and that at the same time the trees were badly affected with "tip blight." This may have been the drouth die-back to be described later.

The drouth spot occurred to a very slight extent in 1913, was prevalent throughout the season of 1914, and in 1915 was abundant early but disappeared after the beginning of the rainy period in July and August. In 1916, which was a very rainy season, the disease was much less prevalent. It occurred to a limited extent in one orchard, and in a few trees in other orchards. In all these cases the trees had been badly diseased in the past. The greater part of the trees which had borne diseased fruit in past years were entirely free from the disease in 1916.

ECONOMIC IMPORTANCE.

Whether it drops from the tree, as in drouth spot occurring early, or persists and becomes deformed, as in cork and late appearing drouth spot, an affected fruit becomes a total loss. Cork usually takes the whole crop of affected trees or of individual branches year after year. In some cases, in favorable years, it has been known to affect the entire Fameuse crop of some orchards. Drouth spot may involve only a few fruits on an affected tree, or may, in some cases, ruin its entire crop. In one orchard, in 1914, it was estimated that the loss from drouth spot was two hundred barrels. Eleven hundred were actually harvested. This, however, is extreme.

At present, these diseases cannot be said to be of great economic importance. They have been serious in comparatively few orchards. The apple-growing area in the Champlain valley is somewhat restricted at present, but is gradually being extended. With the growth of the industry in that locality these diseases may assume considerable importance.

SYMPTOMS.

FRUIT-PIT, BITTER-PIT OR STIPPEN.

The fruit-pit of apples is described by Brooks (2) as follows: "In the early stages of fruit-pit one finds numerous sunken areas from two to six millimeters in diameter on the surface of the apple. These depressions are somewhat hemispherical in shape and have the appearance of bruises. At this stage the spots are not brown and often show no difference in color from the surrounding surface of the apple. They may be a deeper red than the adjacent tissue when occurring on the colored portion of the apple and a darker green when on the lighter parts. Later they begin to take on a brown tint, but at first this seems to show through from rather deeply seated tissue and not to arise from any discoloration of the epidermal or immediately underlying cells. Sections of such spots show that this is the case, and that the browning and shrinking of the cells occur in the pulp of the fruit and in the tissue that is transitional between it and the hypodermal parenchyma. Later the surface cells also become dark brown. The epidermis may be smooth and apparently unbroken in both early and late stages. As the disease advances spots situated near each other often become confluent, developing into one large spot. In all such cases examined it was found that the original spots were closely connected with one vascular branch. The writer has been unable to detect a bitter taste in the browned tissue of the fruit pits.

"*Internal browning of tissue.* The surface spotting is often accompanied by browning of the tissue immediately surrounding the vascular bundles. Upon cutting such an apple one sees numerous apparently isolated brown spots. Further study shows that these are not isolated but are in reality continuous strands of brown tissue surrounding the vascular bundles. The portion of the vascular system that is most commonly affected is that lying within fifteen

millimeters of the surface of the apple. The surface spots often occur without the internal browning and also the internal browning may occur unaccompanied by any surface derangement."

CORK.

Cork is most commonly observed when the apple is in a state anywhere from half grown to nearly mature. It may be briefly characterized as internal browning described by Brooks in the preceding paragraph, without external pits, but with the surface of the apple thrown into a series of elevations and depressions. A large number of brown corky areas occur throughout the flesh, following closely the course of the vascular bundles. In no case do these extend outward as far as the skin, consequently there are none of the external brown pits characteristic of true fruit-pit or stippen. A further difference from the usual type of fruit-pit is that the spots are not more abundant in the peripheral zone, but are scattered throughout the flesh of the fruit. There is no bitter taste connected with this disease in Fameuse apples.

In the earliest observed stage of the disease, when the fruits are about two centimeters in transverse diameter, there is no external evidence of an abnormal condition. The shape of the fruit and the color and appearance of the skin are normal. Upon cutting open the fruits, comparatively large, brown, corky areas are seen at various places in the flesh.* These are often near the periphery directly opposite one of the main vasculars (Plate XVIII, fig. 1); or they may be, in some cases, arranged irregularly within the core lines around the core. Sometimes, in the earliest stage of the disease, the internal brown spots are surrounded by a green water-soaked area suggestive of the well known water-core disease. This area may even show through the skin of the fruit as a darker green

* There has been, locally, some confusion between cork and the injury caused by the apple maggot, or railroad worm (*Rhagoletis pomonella* Walsh.). This confusion is the more excusable since, next to Tolman, Fameuse is the variety most attacked by the apple maggot. There should, however, be no difficulty in distinguishing between the two. Apple maggot injury is first observed in July. The apple is smooth externally. Often a small, dark colored spot shows in the skin around the egg puncture. When cut across, the flesh is seen to be traversed by irregular, yellow-brown streaks which have a water-soaked appearance. In cork, the spots are more regular, definitely outlined, and dry and spongy. In late stages of apple maggot injury the whole apple becomes honeycombed with the feeding tunnels of the maggots and the flesh is reduced to a brown, spongy mass held together by the skin of the fruit. A corky apple never reaches this state of disintegration. Its flesh remains firm.

Variation of lesions.—Peculiar variations from the above-described appearances sometimes occur. Such are: (1) Small red pits near the calyx end of the fruit, found on the Bellflower variety; (2) raised red blisters or pimples, occasionally appearing on Fameuse.

There is no bitter taste, such as has been ascribed to fruit-pit, in an apple affected with drouth spot; but it is insipid, and distinctly lacking in acidity. This may be noticed even in very young green apples, and sometimes in healthy fruits growing on diseased trees.

DIE-BACK AND ROSETTE.

On April 28, 1914, in orchard No. 1 (in the section where the drouth spot had occurred the previous summer), a few trees were noticed with twigs which were not putting out foliage. It was believed at the time that the ends of these twigs had winterkilled and no attention was paid to them beyond preserving material for microscopic examination. As will become evident later, this was, no doubt, die-back originating the previous summer. Some of these twigs died back during the summer of 1914. Others remained alive, but made no growth, their upper buds continuing dormant throughout the summer. Some of the lower buds on these twigs developed clusters of very small, lanceolate leaves with shortened petioles. In some cases the twigs made a very short terminal growth, resulting in a thickened, shortened axis an inch or so long, bearing a cluster of leaves, some normal and some short lanceolate, the general effect being that of a long bare twig capped by a rosette of leaves. This last-mentioned appearance was pronounced by Dr. Charles Brooks to be very similar to the so-called rosette occurring in the irrigated orchards of the Pacific Northwest.

Paddock (19) describes apple-tree rosette as follows: "Some of the trees are dying, while there are a number of dead limbs on others, but the characteristic feature of the disease is a tuft or rosette of small leaves at the end of branches that are otherwise nearly bare of foliage." In this paper the name drouth rosette is applied to the above-described appearance and also to the one in which a cluster of small, lanceolate leaves is found at the base of a twig otherwise bare.

About August 15, 1914, a die-back of the tip of the season's growth was observed in a large number of trees in this orchard.

In these twigs a brown discoloration was evident in the cambial region. This discoloration, in many cases, extended beyond the season's growth, back into the one-year, two-year, and even three-year wood.

There appeared to be several degrees of severity of this injury: (a) The twig and terminal leaves of the season's growth became browned, curled over more or less, and died back, sometimes throughout its whole length but often only partially. Below the dead part the only evident injury was a browning of the cambial region, running down the twig as stated above; (b) the season's growth appeared normal or nearly so, but cambial discoloration was evident for an inch or so back from the tip, and just below the lateral buds; (c) no die-back or cambial discoloration occurred, but there was a premature ripening of the foliage, especially the terminal leaves. These leaves were mottled with pale yellow green and darker green or brown. There was a deep red-brown to purple discoloration along the veins and sometimes over part of the leaf surface, spreading from the tip back over half or more of the leaf, or spreading from the edge of the leaf over part of its surface. From a distance, the foliage of the tree appeared pale yellow-green.*

The appearance of one of these die-back shoots the following summer was that of a completely dead tip from six inches to a foot long, often with a distinct marginal crack between it and the living part below. From some point back of this tip a healthy lateral developed to renew the branch.

Below the dead portion of the twig the bark and cambium were healthy and the discolored zone of the previous fall was found beneath a layer of new xylem. The upper buds on this portion of the branch remained dormant, the lower ones sometimes developed clusters of dwarfed linear lanceolate leaves. The healthy lateral might arise either from above or below the limit of the interior discoloration. Plates XXV and XXVI show types of these die-back twigs, both with and without the dwarfed lanceolate leaves at the base. Plate XXVIII shows trees from orchard No. 1 exhibiting the die-back and rosette.

* This abnormal appearance of the leaves may be noticed quite early in the season as a mottling of deep green and pale green. Unless, however, conditions are favorable for die-back, it does not develop into the condition of premature ripeness here described.

PATHOLOGICAL HISTOLOGY.

CORK.

Under the microscope the internal brown spots of cork appear as aggregations of cells with brown shrunken contents. A number of the cells, though not all, are shrunken and collapsed. Around the corky portion the healthy cortex cells form a ladder-like arrangement of smaller, more nearly rectangular cells. It is as though they had been stimulated to rapid division in response to the decreased pressure from the direction of the diseased area. (See Plate XXII, fig. 1.) Outside of this zone the pulp cells are normal in size and form. The close relation of the dead spots to the vascular system is very evident under the microscope.

DROUTH SPOT.

Superficial lesion with smooth surface.—In this type of spot the disease shows merely as a browning beneath the epidermis — an irregular light brown blotch on the skin. On cutting the fruit across it is found that the flesh is normal, the trouble is only " skin deep." Microscopically, sections of the diseased spots show that the trouble is confined to two or three layers of the hypodermal parenchyma, usually the inner layers, though sometimes the entire hypodermis is affected and a few dead cells are also found in the flesh. The diseased cells retain their normal outline, but their contents have become brown and amorphous. (See Plate XXII, fig. 2.)

Such a spot may be said to be an early stage of the disease. The injury has occurred very recently and the fruit has made no appreciable growth since. Somewhat later, as the skin of the fruit becomes roughened and cracked, there will be noticed, under the microscope, an abnormal tissue forming beneath the dead cell layers. The cortex cells immediately beneath have become nearly or quite rectangular in outline and are apparently dividing in a plane parallel with the surface of the fruit. This seems to be preliminary to the formation of a cork layer between the dead and the healthy tissue. The outermost layer or two of this new tissue have suberized cell walls, a fact determined by testing with chlor-iodid of zinc and with chlorophyl solution. (See Plate XXIII, fig. 2.)

Superficial lesions showing wrinkles.—This type of lesion is one entirely similar to the above except that there appears a definite

wavy pattern formed by a series of small wrinkles in the skin. Microscopically, sections through these spots show a series of slight ridges and hollows in the outline of the circumference of the fruit. There is a characteristic arrangement of dead cell areas with regard to these. In a " ridge " the dead cells may not occur, or if they do, they are mostly confined to one or two layers of the hypodermal parenchyma, the dead areas being noticeably thinner than in the " hollow."

In the hollows the browned area is thick, involving often all of the hypodermis and extending like a wedge into the flesh beneath. The apex of this wedge-shaped area is invariably in close proximity to one of the finer vascular bundles. (See Plate XXIV, fig. 1.)

Small pits, noted especially on the variety Bellflower.—Sections through these pits show the hypodermal parenchyma browned throughout, a brown discoloration in the epidermal cells (the pit is reddish when viewed externally), and a wedge-shaped area in which some of the cortex cells are brown and collapsed. Around this wedge-shaped area the healthy pulp cells have begun to divide in the manner described above under " Cork." There is often a " collection " of vascular branches near the apex of this wedge of diseased cells. This, it will be seen, is very similar to the lesion of fruit-pit or stippen. It should be remembered, however, that these spots were observed in June when the fruits were very small. Fruit-pit does not occur until the fruit is in a late stage of development.

Raised lesions or pimples, noted especially on Fameuse apples.—Sections through these lesions show dead cell layers in the hypodermal parenchyma, and, beneath, a large amount of the tissue which is preliminary to cork formation. The occurrence of this tissue is apparently responsible for the raising of the lesion. The outermost layer or two of this tissue, next to the dead cell layers, give the reaction for suberized cell walls. In many sections the relation of these pimples to the vascular branches in the cortex was very apparent.

Deep-seated lesions.—In this type of the injury the dead cells occur in the flesh of the fruit near the periphery and wedge-shaped areas may be observed extending in toward the vascular bundles. Plate XXIV, fig. 2 shows a cross section of one of these deep-seated spots in which the tissue affected is that which is transitional between

the hypodermal parenchyma and the cortex. Strips of dead tissue are seen extending toward the vascular endings.

DIE-BACK.

Cross and longitudinal sections of die-back twigs made the second season so that the discolored zone is buried by a layer of new xylem, show, when placed under the microscope, that this zone consists of a tissue called by Sorauer (23) "Parenchymholz." This "Parenchymholz" or parenchyma wood is a tissue in which no normal wood fibers and vessels are recognizable. It consists of irregular but nearly isodiametric cells, with comparatively thin pitted walls and large lumina. The cells themselves appear healthy and contain large quantities of starch. The brown color of the parenchyma zone is due to a brown intercellular substance, the nature of which is not known. It has been suggested by the writer (18) that it may consist of the brown amorphous remnants of dead cells lying pressed between the healthy cells of parenchyma wood, but it may result from the degeneration of the primary wall of parenchyma-wood cells.

The early stages of this parenchyma-wood formation may be observed in sections made of die-back twigs of the current season's growth. Such a twig usually shows entirely dead tissue near its tip and a discoloration in the cambial area running back for a variable distance. Under the microscope this discolored zone shows, if the sections are taken near the tip, a large number of cells with browned contents in the cambium, phloem and pericycle. If sections are made from parts of the twig a short distance below, it will be seen that growth has been made subsequent to the injury. The injured cambium has produced a quantity of the so called parenchyma wood, the browned cells of the phloem and pericycle being pushed outward. Finally, the parenchyma zone becomes buried by a layer of new xylem, outside of which are found normal bark and cambium. (See Plate XXVII, fig. 2.)

SEASONAL HISTORY.

DROUTH SPOT.

The opinion of Mr. J. M. Stevens, who had noticed the disease for five or six years in his orchard at Orwell, Vermont, was, as expressed by him in 1913, that its earliest appearance each year

was about the first of July. As the disease had never been serious in his orchard it is possible that in these years the earliest appearance had been overlooked.

In 1913 diseased fruits were first observed on June 24, at Peru, N. Y. This date was about five weeks after the blossoms had fallen. It is probable that these fruits would have been found somewhat earlier if search had been made. The disease was observed by Mr. Stevens in his orchard at Orwell on June 19.

In 1914 the disease was first observed on June 11, when the young fruits were about one and one-half centimeters in transverse diameter. This was only about twelve days after the blossoms had fallen.

In 1915 the disease appeared on June 11, a little over two weeks after the blossoms had fallen.

In 1916 the date was June 8, about ten days after the blossoms had fallen. The fruits were, on the average, slightly smaller than any in which the disease had been observed in past seasons, many of them being only about one centimeter in transverse diameter.

The later seasonal history seems to be largely influenced by weather conditions. The apples affected early soon drop, but if the season continues dry, as in 1914, fresh spots continue to appear on the larger fruits, having been observed as late as the middle of August. The fruits affected later remain on the tree and become cracked and deformed. If wet weather succeeds the first appearance of the disease, as in 1915, the symptoms tend to disappear, and newly formed spots are not in evidence much later than the beginning of the rainy period. If the early part of the season is rainy, as in 1916, the disease does not occur to any considerable extent, and quickly disappears.

CORK.

Cork appears slightly later than the drouth spot, June 19 being the date it was first observed in 1914 and 1915. In 1916 it seemed to be later than usual, not being found until June 30. When first observed there are usually not so many internal spots in any one fruit as later appear. The spots increase in number during the two or three weeks following. According to the writer's observation all apples which show cork when mature can be recognized as "corky" when half grown. Whether the disease can progress or

originate in storage, as true fruit-pit is said to do, cannot be stated. The writer has never been in the locality at a proper time to observe this.

ORCHARD OBSERVATIONS.

In reporting observations on these diseases made during the seasons of 1913 to 1916, the various orchards in question will, for convenience, be distinguished by number; but in anticipation of the desire of some later worker to identify them, the following list, including owner's name and locality, is given.

Orchard No. 1, owned by the Northern Orchard Co., Peru, N Y., J. M. Stevens, Manager.
Orchard No. 2, owned by Peter McGee, Peru, N. Y.
Orchard No. 3, owned by the Champlain Valley Orchard Co., Peru, N. Y.
Orchard No. 4, owned by Victor Weaver, Morrisonville, N. Y.
Orchard No. 5, owned by S. H. Clark and Son, Peru, N. Y.
Orchard No. 6, owned by H. T. Kellogg, Valcour, N. Y.
Orchard No. 7, owned by H. L. Scribner, Plattsburg, N. Y.
Orchard No. 7a, owned by H. L. Scribner, Plattsburg, N. Y.
Orchard No. 8, owned by H. E. Heyworth, Peru, N. Y.
Orchard No. 9, owned by Peter Crilley, Peru, N. Y.
Orchard No. 10, owned by J. W. Harkness, Harkness, N. Y.
Orchard No. 11, owned by G. A. Mason, Peru, N. Y.

DROUTH SPOT.

Orchard No. 1.—This is an orchard of 4000 trees, 3600 of which are of the McIntosh variety. The soil is described in the soil survey of Clinton County (17) as the Dover fine sandy loam, and characterized as a mellow, rather fertile soil, bearing limestone fragments; one of the best types of soil for general farming in the County. The subsoil is, except for some variation in color, identical with the surface soil. Borings made in this orchard to the depth of six feet indicate nothing in the nature of a hard pan, nor any marked change in soil character. This type of soil is, in general, naturally well drained. The trees were seven years old in 1914, when the first serious outbreak of the disease occurred, and were exceptionally well grown and vigorous, with heavy foliage. The method of culture followed in this orchard from the time of planting

up to and including 1914 was to keep a space cultivated next to the tree rows, and to crop the rest of the ground by a three-year rotation of potatoes, oats and clover.

In 1913 the disease appeared on McIntosh fruits in a few trees in the northeast corner of the orchard. This part of the orchard was in oats. While at first appearing on only a few fruits the amount of disease gradually increased until it affected nearly all of the apples on each tree. The loss in this season, however, was very slight. The only other observation of the disease in 1913 was of a few affected apples on one tree in orchard No. 7. This tree stood in cultivated ground.

In 1914 the disease appeared on a few trees in the part of the orchard where it was found the previous year, and was at first confined to that part of the orchard. This section of the orchard was in clover in the early part of 1914, being plowed in July.

The disease was first observed on June 11; on June 18 it was found to have increased in the area where it was originally found and was also noticed in other sections of the orchard. The earlier affected fruits were dropping. This drop continued later, and is characteristic of the disease on fruits affected when very small.

On June 24 the disease was observed to be more or less prevalent throughout the orchard on scattering trees, often one tree being affected while the next neighboring tree remained free from the disease. This is characteristic of the trouble. The disease on this date appeared to be nearly as prevalent in the cultivated parts of the orchard as in the sod parts. When first observed the disease was confined to a few apples on each tree, but by this time nearly every apple on each affected tree had become diseased. An estimate of the probable loss on this date was 25 per ct. of the crop of the orchard.

On July 3 the disease was observed to be still increasing. It now appeared on larger apples, most of the fruits affected earlier having dropped. It was not, however, apparent that the number of trees bearing diseased fruit had increased. The disease could not be said to be "spreading" as a parasitic disease is understood to do.

On July 20 the disease was observed to be still increasing, early stages (superficial type of lesion) being found on fruits 4 to 5 centimeters in diameter. These early stages continued to be in

evidence as late as August 10. Apples affected as late in the season as this did not drop as the fruits affected earlier did, but hung to the tree and became cracked and deformed.

While the disease occurred to some extent in practically every part of the orchard in this season, four separate areas could be distinguished in which it was much more prevalent than elsewhere. These will be called sections 1, 2, 3 and 4. Section 1, where the disease was first observed, was, as stated above, in clover in 1914; section 2 was in oats; section 3, which was the most badly diseased part of the orchard, and in which a large amount of the summer die-back occurred in 1914, was in a neglected condition. It was intended to cultivate this part of the orchard, but the soil became so hard and dry that plowing was considered impossible. It was, therefore, left untouched throughout the season. Section 4, in which the disease occurred to a less extent than in the other three, was planted to potatoes, and benefited by their cultivation.

In 1915 the disease was first observed in this orchard on June 11. At this date affected fruits were found in about twenty trees, in the parts of the orchard where it had been most prevalent the preceding year, and only in trees which showed the rosette and die-back injuries.

By June 22 the disease had increased. It was now found to occur on trees whose foliage was nearly normal. However, it was possible to find a little die-back in every affected tree.

In this and in other orchards in 1915, the spots on the smaller fruits were more deeply sunken than in other seasons, and showed internally brown, corky areas and cavities extending in to the main vascular branches. In other words, the disease at this time appeared more suggestive of the "confluent bitter pit" or "crinkle" described by McAlpine than at any other period while the disease was under observation. Plate XIX, fig. 2 and Plate XX, fig. 1 are photographs of diseased fruits from this orchard made in June, 1915.

On larger fruits the lesions became more nearly the superficial type of lesion described above. There was, however, comparatively little of this type in 1915, since the disease did not develop fresh stages later than July 1, when the spring drouth was broken. The rest of the season was very rainy and drouth spot was not in evidence.

Beginning with 1915 a new plan of culture was adopted in this orchard, viz., to grow a crop of potatoes one year and to practise

clean cultivation followed by a cover crop the succeeding year. One-half of the orchard was to be planted to potatoes and the other half cultivated each year. Of the diseased areas mentioned above, sections 1 and 2 were in the part of the orchard which was planted to potatoes in 1915; sections 3 and 4 in the cultivated part. There was less disease in sections 3 and 4 than in sections 1 and 2, but the crop was extremely light in the former areas, so that this fact is not especially significant.

In 1916 the disease was first found in this orchard on June 8, showing then as a superficial spot. It was at first found on a single tree, standing in section 1, where the disease had always been prevalent. This tree and the neighboring trees had suffered severely from rosette and die-back. There was, however, nothing to distinguish it from the surrounding trees. A large proportion of its fruit was affected while none of the nearby trees bore diseased fruit. Further search resulted in finding two more trees in this section of the orchard, but somewhat removed from each other, bearing a large number of fruits showing the drouth spot. No diseased fruits were found on the surrounding trees. Search was made in the other parts of the orchard, especially where it had appeared in 1915, but the drouth spot was not found.

This section of the orchard had not been carefully cultivated up to this date, but the spring had been very rainy, and it hardly seemed possible that the trees could be suffering from lack of moisture.

On June 9 eight trees were found showing the drouth spot and on June 10 the number was increased to twelve. All of these trees showed die-back and all stood in the " sick " part of the orchard. Some of these trees bore a large number of diseased fruits; on some only a few fruits were affected. Many trees showing die-back bore good crops of healthy fruits. This had never been observed in previous seasons.

On June 15, 1916, one week after the disease first appeared, careful search resulted in finding it evident to some extent in all parts of the orchard. In all, about thirty trees were found showing the drouth spot. The amount varied from a few apples on a tree to about two-thirds of the crop. All of these trees, without exception, showed die-back injury dating from the summer of 1914. More of these trees were in section 1 of the orchard than in any

other. There seemed some indication in favor of the cover-crop treatment, as in parts of the orchard which bore cover crops only one tree was found showing the disease. This was in a section where the cover-crop was spotted, and may have been in a light spot.

On June 20 the situation in this orchard did not seem greatly changed, but it appeared that the disease was not increasing so fast as it had been. Most of the diseased fruits appeared to have been affected for several days, had stopped rapid growth, were slightly shrunken in the region of the lesions, and in a few cases showed dead tissue extending into the flesh. Such fruits, when cut across, showed dead brown areas and, occasionally, cavities running into the flesh toward some of the main vascular branches, as was observed in 1915. A number of fruits were found on which the spots appeared recent, but the disease had apparently increased much less during the period from June 15 to 20 than it did from June 8 to 15. On the latter date search was made in section 3 of the orchard where the vetch-and-buckwheat cover-crop was turned under in the spring and the disease was found on one tree in the extreme edge of the plat. This section was badly diseased in 1914. The soil at that time was in poor physical condition. It had become too hard to cultivate and was left untouched. (In 1915 this section was carefully cultivated and sowed with a vetch-and-buckwheat cover crop.)

On June 27 the distribution of the disease in this orchard was much the same as on June 20. It had not appeared on any trees that were not affected on the earlier date. It still appeared only on trees showing the die-back or die-back and rosette injuries. It was still possible to find a number of fruits showing early stages of the disease, some, even, with exudate, but the disease was not increasing to any appreciable extent. The spots were still superficial in the early stage, showing corrugation very markedly. Old spots usually showed internal brown corky areas, as mentioned above; but no severe sunken lesions, such as occurred in 1915, could be found. A number of the earlier affected fruits had dropped. Some still persisted and were beginning to show surface roughness and cracks.

On July 12 the increase of the disease was apparently past, there being practically no fresh stages. In fact, the loss in this

season nearly all occurred during the first two weeks after the appearance of the disease.

Orchard No. 2.—This is a small orchard of mixed varieties, principally Fameuse, McIntosh and Northern Spy, on the farm adjoining that of orchard No. 1. The soil on the two farms is the same. The orchard was carefully cultivated during the early part of 1914, and sowed to buckwheat early in July. The trees were about twenty years old in 1914.

The disease was observed on July 3 on Northern Spy apples, and a few days later on McIntosh. Several Northern Spy trees bore affected fruit, but only two McIntosh. Many of the Northern Spy trees were suffering from winter-killing of the roots, which had occurred the preceding winter. None of the McIntosh were so affected. Affected fruits could, no doubt, have been observed at an earlier date had a visit to the orchard been made. The progress of the disease in this season was identical with that described for orchard No. 1.

In 1915 the disease was found in this orchard on June 16, in a few Fameuse trees. These trees were suffering from rosette and die-back. The Fameuse fruits affected showed both the external drouth spots and the internal spots of cork. Many of them showed genuine cork, with no external abnormality.

On June 22 more Fameuse trees were found showing the drouth spot and cork. The McIntosh trees which bore diseased fruit in 1914 and which were also affected with die-back, showed the drouth spot. The Northern Spy trees which showed the drouth spot in 1914 were badly affected with die-back but did not bear fruit in 1915.

As in orchard No. 1, the drouth spot did not develop later than about July 1. Most serious in this orchard in 1915 was cork, appearing alone and also in association with the drouth spot. The orchard was in clover in 1915 and the crop cut for hay.

In 1916 a crop of clover hay was again raised in this orchard. All of the trees bore, including the Northern Spys. Neither drouth spot nor cork appeared during the season. The crop was healthy.

It should be stated that during these three years both the drouth spot and cork appeared in a certain restricted area in this orchard. This area is slightly higher than other parts of the orchard, and, according to the owner's statement, its soil is drier.

Orchard No. 3.—This is a small orchard of two varieties, Fameuse and McIntosh, the Fameuse being about twenty years old, the McIntosh about ten. It occupies one side and the bottom of a small creek gully, sloping to the southeast. One corner of the orchard occupies the highest part of the ridge of the slope. In 1914 this area was sowed to oats and the part lying lower was carefully cultivated. The soil is described in the Clinton County survey as the Dover gravelly fine sandy loam, not greatly different from the Dover fine sandy loam. It is a soil found occupying small ridges and slopes through the uplands. It is stated that on account of the loose, porous nature of the subsoil, crops sometimes suffer from lack of moisture during periods of dry weather. This statement is not made regarding the Dover fine sandy loam.

The disease was first noticed in this orchard on July 8, 1914, but was probably evident before that date. Every Fameuse tree in the higher part of the orchard bore diseased fruit and nearly every fruit on affected trees became diseased. None of the Fameuse nor McIntosh in the lower lying part of the orchard showed the disease. (There are no McIntosh trees in the higher part.) The diseased Fameuse fruits showed both the external and internal lesions characteristic of drouth spot and also the internal lesions characteristic of cork.

In 1915 the whole of this orchard was kept under careful cultivation. The disease was observed here on approximately the same date as in orchard No. 1. A description of its occurrence in 1915 would be repetition of the statement just made regarding conditions in 1914.

There was no drouth spot in this orchard in 1916, but some cork occurred as mentioned later.

Orchard No. 4.—This is a mixed orchard of McIntosh, Northern Spy and Fameuse. The trees were about fifteen years old in 1914, and were well grown, with heavy green foliage. The soil is the Dover fine sandy loam. Careful cultivation is practised in this orchard every year.

In 1914 the disease was first observed on June 22. On this date numerous diseased fruits were found on one McIntosh tree in a corner of the orchard. By July 7 the disease involved about two-thirds of the crop of this tree, most of the affected apples being found on the lower limbs. A few diseased fruits were found on the next

tree, also a McIntosh. The disease was not found on other McIntosh trees nor on Fameuse, but occurred on two Northern Spy trees in the row next to the one containing the affected McIntosh trees.

In 1915 the disease was observed in this orchard on June 19. It occurred on the two McIntosh trees which bore affected fruit in 1914 and also on one McIntosh tree in another part of the orchard. This tree was not diseased in 1914. The Northern Spy trees on which the disease was found in 1914 were affected with die-back of the previous summer's origin, and rosette, but did not bear fruit in 1915.

Search was made for drouth spot in this orchard on June 21, 1916. Two-thirds of the apples on the one McIntosh tree where the disease was first found in 1914 were affected on this date. The disease was not found on either of the other two McIntosh trees which had borne diseased fruit in the past. It is to be noted that the McIntosh tree in question is the one which has each year been most seriously affected, both with drouth spot and with die-back and rosette. The set of fruit on this tree was poor as compared with other McIntosh trees in the same orchard, although it had blossomed fully as well. One of the Northern Spy trees, showing more die-back than the other, bore a very few diseased fruits.

Contrary to the usual practise this orchard was not cultivated in 1916 but was left to grow up to quack grass and weeds.

Orchard No. 5.—This is a large orchard of several varieties: McIntosh, Fameuse, Northern Spy, Ben Davis, Baldwin. The soil is described in the Clinton County survey as the Coloma fine sandy loam, a soil differing from the Dover fine sandy loam chiefly in the absence of limestone fragments and in a generally lower agricultural value. The crops on this farm are, nevertheless, usually good. The orchard is well cultivated each year and a cover crop sowed in July. The trees are about twenty years old.

The disease was observed in this orchard on July 6, 1914. A large number of McIntosh and a few Fameuse and Ben Davis trees were found bearing affected fruits. Later, the disease was found very prevalent on Northern Spy. The diseased Fameuse fruits, as in other cases, showed both drouth spot and cork lesions, and there were, in addition, several Fameuse trees which bore full crops of fruit affected with genuine cork, no external spots being evident. The disease was largely confined to one section of the orchard,

but no difference in soil or treatment between this and other sections could be observed.

In 1915 drouth spot was found in two or three McIntosh trees in this orchard on June 18. These trees also showed the die-back and rosette injuries. Many of the McIntosh trees which were affected the previous year did not bear. The Northern Spy trees which bore diseased fruit in 1914 were observed to be affected with die-back. They did not bear in 1915. There was some drouth spot on Ben Davis, and also a little cork on Fameuse, but as the Fameuse crop was very light, most of the trees not bearing, these observations are of no particular value.

There was very little drouth spot and no cork in this orchard in 1916. One Ben Davis tree in the affected section of the orchard showed a type of the disease which seemed transitional between drouth spot and cork. A number of nearby Ben Davis trees which had been badly diseased with drouth spot in the past two years, and which showed the foliage abnormalities, bore large crops of healthy fruit in 1916.

One fact without satisfactory explanation is the occurrence in 1916 of typical drouth spot in three Baldwin trees in this orchard These trees had never, to the writer's knowledge, exhibited the disease. They did not bear in 1915 and were either healthy or escaped the writer's attention in 1914. That the latter may be the explanation is probable, since they were badly affected with die-back. These trees stood in a remote corner of the orchard.

The Northern Spy trees which were badly diseased in 1914, and in which the die-back occurring that year was still evident, bore a large crop in 1916, but no fruit affected with drouth spot could be found.

Orchard No. 6.—This is a mixed orchard of old trees, 60 to 75 years old, Fameuse being the variety most represented. The soil is described in the Clinton County survey as the Dover loam, a soil recognized as the strongest in the county. The land slopes to the east toward Lake Champlain, has good surface drainage, but is not underdrained, though apparently needing such treatment. It is usually wet late in the spring. In 1914 the orchard was plowed early and left for some time before harrowing. It was later harrowed at considerable intervals and in such a way that the soil was in bad, lumpy condition between harrowings. This bad condition was

evident at the time of the first observation of drouth spot and cork in this orchard.

The disease was first observed on June 24. Varieties affected were Fameuse, Bellflower and Oldenburg. On July 8 it was estimated that 75 per ct. of the Fameuse fruits in this orchard were diseased. As in the case of the Fameuse in orchard No. 3, all of these diseased fruits showed the internal spots characteristic of cork, often with no accompanying external lesions though many of them also showed the external drouth spots. There was practically an entire crop loss from these Fameuse trees when picking time arrived.

In 1915 specimens of drouth spot were found on one Fameuse and one Oldenburg tree on June 16. Some of the other Fameuse trees showed a little die-back and rosette, but their fruit was normal at this date. Subsequently, cork developed in these Fameuse, involving practically the whole crop of the orchard. The orchard was cultivated early and sowed to oats.

In 1916 neither drouth spot nor cork occurred. This is remarkable in view of the widespread occurrence of cork in the previous years. The orchard was in clover in 1916, which, in connection with the rainy season, undoubtedly caused better soil moisture conditions than in 1914, when the soil was in hard, lumpy condition, or in 1915 when a crop of oats competed with the trees during a very dry spring.

Orchard No. 7.—This is a large orchard of McIntosh, Wealthy, Northern Spy, Fameuse and other varieties. The trees are about twenty-five years old and in good condition. The soil is the Dover fine sandy loam. Cultivation is practised next to the trees, a strip of sod being left in the center of the row. The drouth spot appeared in one McIntosh tree in 1913, and took the whole crop of several McIntosh trees in 1914. In 1915, on June 28, one tree which bore affected fruit the previous year was found showing the disease. This tree and several others which bore diseased fruit the previous year showed the die-back and rosette injuries (of the previous summer's occurrence). No additional cases of the disease in McIntosh fruits were found; nor did any of the Wealthy trees in the orchard show the disease.

In contrast to the above, in an orchard across the highway, orchard No. 7a, a large number of Wealthy and Fameuse trees bore diseased fruit in 1915. The Wealthy trees, in particular, had

an over-load of small fruit and every apple became affected with drouth spot. Several of the Fameuse trees had borne corky fruit the year before. No die-back or rosette was found in these trees. This orchard was cultivated, but very poorly. The soil was in a hard, lumpy condition at the time the disease was first observed, and for some time before. The soil type in the two orchards is the same.

No drouth spot occurred in either orchard, No. 7 or No. 7a, in 1916. Cork, however, was present to some extent, as mentioned later.

Orchard No. 8.—This is a small orchard of McIntosh, about eighteen years old. The soil is, again, the Dover fine sandy loam. The orchard is in sod, and usually bears a heavy crop of hay. The drouth spot had never appeared here until 1915, when it took a large portion of the crop. There was no die-back or rosette injury. There was no disease in this orchard in 1916.

Orchard No. 9.—This is an old orchard of several varieties including a row of half a dozen McIntosh and three Fameuse along one side next to the highway. The trees are about twenty years old. The soil is the Dover loam. The orchard is in sod and generally neglected as to pruning and spraying. The soil moisture conditions in this orchard do not appear good. Even in a season of abundant rain the soil becomes dry and hard. Borings in this soil to a depth of four feet did not reveal a hard pan.

The drouth spot took nearly the whole crop of the McIntosh trees in 1914, and in 1915 was equally severe, except that some fruits escaped, due to the general failure of the disease to develop after July 1. Die-back and rosette developed in these trees following the summer of 1914. In the spring of 1916 they were in worse condition from these foliage abnormalities than any other trees found. One or two appeared in almost a dying condition. Die-back and rosette were also very severe in the Fameuse trees. This was extraordinary, since few Fameuse trees in other orchards have been observed showing them, and then only to a very slight extent.

In 1916 this orchard was one of the few in which drouth spot occurred. It was found in four of the diseased McIntosh trees. It did not, however, involve the whole crop of these trees. In no case was more than one-half of the fruit affected. The crop on these trees was light. One McIntosh tree, which seemed in a better

condition than the others, showing less of the die-back and rosette, bore a large crop of healthy fruit. Cork occurred in the Fameuse trees, as mentioned later.

Other orchards.—In addition to the orchards described above, drouth spot has been found in several others at different times. Some of these cases will be mentioned briefly.

In 1915, in particular, the disease was observed in several orchards in which it had not appeared in either of the two preceding years. The case of orchard No. 8 has been discussed above. Notable was the occurrence, this year, of the drouth spot in three trees in an orchard where the soil was rich, mellow, and in the best possible tilth. In no instance where the disease occurred in 1915 for the first time was there any of the die-back or rosette.

In the years 1914 and 1915 the drouth spot was found occurring in an orchard at Gordon's Landing, Vermont. The soil here is heavier than in Clinton County, N. Y., and shallow, being underlaid by limestone which comes to the surface in many places. This orchard was not visited in 1916.

In the same seasons drouth spot occurred in a few McIntosh trees in a young orchard near Crown Point, N. Y. These trees stood in very shallow soil, with rock close to the surface and outcropping nearby. In 1916 there were a very few diseased fruits on these trees, the great part of their crop being healthy. In this season drouth spot was also found on another McIntosh tree which stood on a ridge of land in this orchard. This tree and other nearby trees appeared in a very much weakened condition, the cause of which was not ascertained.

An orchard in which the disease has been severe is that owned by Mr. J. M. Stevens at Orwell, Vermont. The writer did not visit this orchard except in 1916. The observations here reported were made by Mr. Stevens, but as he is manager of orchard No. 1, and has watched the disease closely in both orchards, they should be accepted as reliable.

There was a considerable amount of the drouth spot in this orchard in 1914. It seemed to be confined to the drier parts of the orchard. Die-back occurred on a few trees.

In 1915, under comparatively clean culture, the disease was quite prevalent in the "shaly" parts of the orchard. The soil here is a clay loam in which shale fragments are abundant. It is underlaid

by shale, and in many places is shallow. In a small block of trees where the soil is the same, but where a crop of sweet clover was grown, cut and left as a mulch, the disease did not develop. The clean-cultivated parts of the orchard were seeded to alfalfa in August. In 1916 very little disease developed. It occurred to a very slight extent on six trees.

Part of this orchard stands on a deeper soil of heavy clay loam, not carrying shale fragments. Only three trees in this part have shown the disease. They were badly diseased in 1914. They then stood in poorly drained places where, during the spring drouth, the soil was lumpy and hard. These places were tiled, and in 1915 there was much less disease on the trees. In 1916 a few diseased fruits were found on one of them.

CORK.

True cork as distinguished from drouth spot was quite prevalent in Clinton County in 1914. Its occurrence where the internal lesions were associated with the external drouth spots has been mentioned above. The following observations are on the disease as it usually appears; viz., as an internal spotting with the outer surface of the fruit smooth in the early stage, but later becoming lumpy and knotty due to uneven growth of the tissues.

The disease was first observed on June 24, in orchard No. 6, as mentioned above. At this time the fruits were from about one and a half to two centimeters in diameter.*

In most of the orchards studied the disease appeared on trees which could in no way be distinguished as to growth, vigor, or favorable location from neighboring trees that were free from the disease. Usually, the entire crop of a particular tree was corky. Sometimes the entire crop of certain branches was affected, the apples on other branches of the tree remaining normal. The owners of the various orchards under observation stated that certain trees, and even certain branches of some trees, were particularly susceptible to cork; also, that these trees always bore corky fruit if any in the orchard did.

Nothing very definite as to the moisture relations in most of these orchards could be learned. In several well cultivated orchards

* McAlpine (13) states that the earliest stage of the disease observed by him in New South Wales was on November 30, when the fruits were "about the size of a walnut."

there were very few trees bearing corky apples, and in a few there were none. One sod orchard, No. 10, was remarkable. It is a small orchard containing about twenty Fameuse trees twenty years of age, and a few trees of other varieties. The soil is the Coloma fine sandy loam. At the time of observation, in August, it was very dry and hard. A heavy crop of hay had been grown in this orchard. The Fameuse trees bore heavily in 1914. Their entire crop was corky, deformed and small, and the trees did not make much growth.

One other orchard deserves special consideration. This is orchard No. 11, a small orchard, mostly of the Fameuse variety. The soil is the Dover fine sandy loam. The orchard was in sod, bearing a light crop of grass. The trees, about twenty years old, were vigorous, and made a good growth in 1914, with heavy, dark green foliage. An exception was found in a row of trees along one side of the orchard and next to a row of elms. These trees were less well grown and smaller than the other trees in the orchard. They made less growth in 1914, their foliage was paler and yellowish. All of their fruit was corky, while other trees in the orchard bore healthy fruit.

Cork was somewhat less prevalent in 1915 than in 1914. It occurred along with the drouth spot in orchard No. 2 and orchard No. 3, in the same trees that were diseased the year before. The trees in Orchard No. 6 which bore fruit showing both drouth spot and cork in 1914 were badly affected with cork in 1915. In various other orchards certain trees and individual limbs of trees which bore corky fruit in 1914, did so also in 1915. The Fameuse trees in orchards Nos. 5, 10 and 11 which had been diseased in 1914 did not, in most cases, bear in 1915. The few trees that did bear, bore corky fruit. The Fameuse crop of 1915 was very light throughout the locality.

Cork was very scarce in 1916. It was found in two trees in orchard No. 9. These trees, as elsewhere noted, were badly affected with rosette and die-back. Cork also occurred in four trees in orchard No. 3. These trees were some of those which had borne "corky" fruit in the preceding two years. The Fameuse trees in this part of orchard No. 3 have the reputation of having never borne healthy fruit. Some of them did so, however, in 1916. Cork was also found in five trees in orchard No. 7a, these being trees

previously diseased. With these exceptions, cork was absent this year from the orchards under observation, even from trees which had been looked upon as "corky" trees, that is, which could be relied upon to produce specimens of the disease every season. Particularly striking was the complete absence of cork from orchard No. 10, though this orchard was again in hay; from orchard No. 6; and from the row of trees in orchard No. 11, in which it had occurred in 1914.

DIE-BACK AND ROSETTE.

The first manifestation of these foliage abnormalities in 1914 was the appearance of bare tips due to the failure of the buds to start in the spring. This was first seen in orchard No. 1. Later in the season many of these tips died back and developed the peculiar condition described above (page 483) as rosette. On July 13 the writer visited a number of orchards near Peru in company with Dr. Charles Brooks of the Bureau of Plant Industry. At this time Dr. Brooks pointed out the occurrence of this peculiar condition in orchard No. 1 and its apparent association with the drouth spot, and mentioned its similarity to the trouble known as rosette occurring in the apple-growing regions of the Pacific Northwest.

Subsequently, die-back and rosette were observed in various orchards; viz., in orchard No. 2, on the Northern Spy variety; in orchard No. 7, on McIntosh; and in orchard No. 9, on McIntosh. In all these cases it occurred on trees which bore diseased fruits. It was reported, also, on such trees in the orchard of J. M. Stevens at Orwell, Vt.

These foliage abnormalities were most prevalent in orchard No. 1, in that section where the diseased fruits had been found the preceding year, and where they were especially abundant in 1914. There was further apparent association of these abnormalities with the disease on the fruit. Every tree in this orchard which was affected with them bore diseased fruit, if it bore at all. Some did not bear. Some trees were found with diseased fruit, but with normal foliage.

The die-back and rosette, while occurring, did not appear serious in extent in orchard No. 1 in 1914. It must be stated, however, that a large amount of pruning was done by the manager throughout the summer, when the diseased foliage was removed.

As early as July 21 the premature ripening of the leaves described on page 484 had become evident, and was more noticeable by the middle of August. This was nearly universal throughout the portions of the orchard in which the diseased apples had appeared, occurring in trees which bore diseased fruit and in trees which showed the die-back and rosette.

About August 15 the die-back of the current season's growth was first noticed. It occurred in a large number of trees in the drouth spot sections of the orchard. It was quite prevalent and continued to appear as late as September 15, when the writer left the locality. The manager of the orchard reported that it continued even later, and expressed the opinion that it was responsible for the widespread occurrence of the die-back evident in the spring of 1915.

In 1915, die-back, resulting from the death of the season's growth the summer before, was prevalent in several orchards. The same trees usually showed some of the rosette, though this was less conspicuous. These abnormalities were most serious in orchard No. 1 where the drouth spot was also most evident; but they occurred in other orchards in trees which bore diseased fruit the previous year, and where the die-back of the season of 1914 occurred. All of these trees that bore in 1915 bore diseased fruit. Some of them, particularly the Northern Spy variety, did not bear.

The following are some of the orchards in which drouth spot and summer die-back occurred in 1914 and the die-back was prominent in the spring of 1915: Orchard No. 1, on McIntosh, about twenty trees seriously affected, and a large number of others less so; orchard No. 2, on Northern Spy and Fameuse; orchard No. 4, on McIntosh and Northern Spy; orchard No. 5, on McIntosh and Northern Spy; orchard No. 6, on Fameuse; orchard No. 7, on McIntosh; and orchard No. 9, on McIntosh.

Fresh die-back of the current season's growth was observed in orchard No. 1 about August 15. It was much less in extent than that occurring in 1914; in fact, was found only in a few trees.

Somewhat more common than this die-back, though much less prevalent than in the preceding season, was the premature ripening of the foliage described on page 484 under c. In connection with this a significant appearance was evident about September first. The season of 1915 was abnormal, May and June being excessively dry, while July and August were rainy. In consequence, many

trees stopped growth early and later put out new growth, amounting to a foot or more on some branches. Several branches showed the typical premature ripening in their lower portions. This stopped abruptly and was succeeded above by a foot or so of new and normal growth, as though the incipient injury had been arrested by the resumption of growth. On the same trees were found twigs that had not started to grow a second time but presented the prematurely ripe appearance of terminal leaves which is believed to be the first stage of die-back.

The above would indicate that the die-back occurs during a period of drouth and may be arrested by a succeeding moist period. This would explain the greater amount of die-back in 1914, since that season was not only dry in May and June but the drouth continued throughout the summer.

In the record of orchard observations some emphasis has been placed upon soil type. This has been done to bring out the fact that these diseases occur on the best types of soil in Clinton county and are not connected with any marked condition of infertility of the soil. While they are found chiefly on one soil type, the Dover fine sandy loam, there is no ground for suspecting a wrong condition peculiar to this soil. There is a greater number of productive orchards on this type of soil than on any other. In certain instances the presence of the drouth spot seemed connected with a condition of shallow soil, but borings in two of the worst affected orchards revealed a deep soil with nothing in the nature of a hardpan, unless at a considerable depth. It is apparent that these diseases may occur in the best soils of the county under thorough cultivation, and in young vigorous trees, as readily as under less favorable conditions.

ECOLOGY.

FRUIT-PIT OR STIPPEN.

Sorauer (23) states that in Germany stippen occurs commonly on loose soil and in dry years. It affects mostly soft-fleshed, early varieties. Firm-fleshed sorts suffer little. In England, the disease is said to occur with alternation of sun and shower, or even of heat and drouth. The season of 1911 was hot and dry, followed by sudden rains. Stippen was abundant. In 1912 the season was rainy throughout, and there was very little stippen (McAlpine [13]).

McAlpine (13) states that in Australia the prevailing opinion is that this disease occurs mostly in wet summers. A few growers have experienced it in dry seasons. It is believed that when rainfall is equally distributed and the rains not followed by a period of drouth stippen is not so serious. A light crop with abnormally large fruit is more liable to stippen than a heavy crop of average sized fruit equally distributed over the tree. Young and vigorous trees making rapid growth may have pitted fruit from rapid transpiration and excessive growth interfering with the regular development of the vascular network.

Brooks and Fisher (3), conducting irrigation experiments with fruit-pit, found that heavily watered trees, especially trees heavily watered late in the season, had a greater percentage of diseased fruit than trees receiving medium or light watering.

DROUTH SPOT, CORK AND DIE-BACK.

The writer's observations show that these diseases may occur in both wet and dry seasons. There is, however, a marked relation of weather conditions to the disease. They tend to disappear during wet weather and are much more serious during a dry period, especially dry weather occurring early in the season. The following statements will serve to make this clear. The spring of 1914 was very dry and there was a great deal of high wind. The drouth continued through the summer. There was an abundance of drouth spot, of cork and of die-back of the current season's growth. It was dry and very windy early in the season of 1915, but July and August were rainy. Under these conditions drouth spot was abundant early, on the smaller fruits, and in a severe form. It even occurred on trees which had not suffered in previous years. It failed to develop on the larger fruits during July and August. Cork was quite prevalent in this season, the injury appearing before the dry period was over. Die-back of the current season's growth was inconsiderable, occurring only in a few branches of certain badly affected trees. There was considerable evidence of recovery from preliminary stages of die-back, the twigs making a large amount of vigorous growth beyond the unhealthy part.

The spring of 1916 was rainy. Drouth spot and cork were not entirely absent, but were greatly reduced, appearing only in trees which in past years had been very badly diseased. Drouth spot

appeared early, in a milder form than in 1915, and had stopped development by the end of June. Cork was slightly later in appearance than usual, and occurred in inconsiderable amounts. Summer die-back did not appear.

The following table gives the record of rainfall during the seasons under discussion. The records were taken by Mr. J. W. Harkness, cooperative observer of the U. S. Weather Bureau, at Harkness, N. Y., four miles from Peru, and probably represent with fair accuracy the rainfall during those seasons for the apple-growing sections of the lower Champlain valley.

TABLE I.—RECORD OF RAINFALL AT HARKNESS, N. Y., DURING THE YEARS 1913-16.

Year	May	June	July	August
	In.	*In.*	*In.*	*In.*
1913	2.09	1.45	3.78	1.15
1914	.44	2.64	1.75	2.93
1915	1.14	1.93	4.48	4.17
1916	3.25	3.68	....	....
Average 10 years — 1903-1912	2.41	3.29	3.66	2.22

CAUSE OF THE DISEASE.

GENERAL DISCUSSION.

It is evident that we have under consideration, not two distinct apple diseases, but, at the most, two types of the same disease: (a) Drouth spot, with which are associated abnormalities of the foliage, called drouth die-back and drouth rosette; and (b) cork, which may occur in association with drouth spot, but which often occurs independently, and is then not associated, except rarely, with any disease of the foliage. Cork is most common in the Fameuse variety.

Before formulating a theory as to the cause of these diseases certain possible causes need to be eliminated. A discussion of these follows:

PARASITIC ORGANISMS: FUNGI AND BACTERIA.

Certain facts operate against considering a parasitic organism the cause of these diseases. They do not seem to be infectious, that is, to spread from one tree to another after the manner of parasitic

diseases, but rather to affect certain trees in certain locations, and, in the case of cork, even certain branches of one tree, season after season. In the case of drouth spot, the lesion appearing on the surface of the fruit does not increase in size. This was determined by drawing rings around several spots and watching developments as the fruit remained on the tree. Indeed, in both drouth spot and cork the trouble seems to be an injury rather than a disease. After the injury occurs subsequent changes seem to be due to further growth of the fruit and attempts to outgrow the injury. There is no progressive development of the disease. The very apparent association of the lesions in the fruit with the vascular system suggests that the trouble is of non-parasitic origin, and reveals a marked resemblance to fruit-pit or stippen, a trouble with which a number of competent workers have been unable to connect any parasitic organism.

In addition to the above, some first hand evidence was sought. A large number of sections have been made of lesions on the fruit, and of the discolored portions of the die-back twigs, and various staining agents employed; but in no case could any organism be found associated with the injured cells. In the fall of 1914 and in the early summer of 1915 several attempts were made at isolation of an organism from die-back twigs by planting bits of diseased tissue in plates of nutrient and potato agar. A few similar attempts were made with bits of tissue from drouth-spot-injured apples. None were made with cork. All of these attempted isolations were without result.

INJURY BY INSECTS.

Specimens of the drouth spot were submitted to Prof. G. W. Herrick and Prof. C. R. Crosby of the Department of Entomology, New York State College of Agriculture. It was their opinion that the injury was not caused by insects and that it was unlike any known insect injury to apple fruits.

SPRAY INJURY, MECHANICAL INJURY, SUNSCALD.

The evidence is against any of these causes. The drouth spot does not resemble spray injury in any recognized form, but the significant fact is the occurrence of both these diseases in sprayed or unsprayed orchards indifferently. They usually first appear between the dates of the calyx spray and the second codling moth

spray, and in orchard No. 1, where the drouth spot has been most prevalent, no application later than the calyx spray has ever been made. Mechanical injury of the fruit brought about by rubbing against branches in the wind sometimes occurs, but this is quite different from drouth spot. It consists in brown, leathery areas in the skin of the fruit, usually with small scratches or holes, evidences of the rubbing. The position of the fruit in the tree does not allow consideration of the idea of sunscald, for the disease occurs in any part of the tree, inside or out, and on any side of the fruit, whether shaded or sunny.

WINTER INJURY.

The idea that winter injury may be directly responsible for the die-back and rosette injuries of these trees is not tenable, since the initial stages of die-back occur in late summer to growth which has been made that season, and to twigs in which the wood of the previous year is entirely normal. Although the writer (18) has observed that formation of parenchyma wood, such as occurs in these die-back twigs, follows winter injury to the cambium, it seems that here it follows some cambial injury which takes place during the growing season.

There was in this locality, in the winter of 1913-1914, a considerable amount of winter injury to the roots of apple trees. It was thought that winterkilling of the roots might be associated with the die-back and rosette injuries. Examination was made, in May, 1915, of the roots of some of the trees in orchard No. 1. Surface roots, which, in the cultivated parts of the orchard, could easily be reached, showed, in many cases, browned centers and live outer parts, as though they had been injured by cold during the winter of 1913-1914 and had laid down one season's growth outside the injured portion. This condition, however, was found in trees with normal foliage and fruit, as well as in those affected with the drouth spot, die-back, and rosette injuries. Three trees which were very badly affected with die-back and rosette were removed and their root systems examined. A fourth tree, in like condition, was given a severe pruning, but as in 1916 its appearance was not improved, it, too, was dug up and examined. Three of these trees showed, just below the union of stock and cion, a large amount of corky, rough, outer bark while the bark underneath was normal. The fourth tree showed a small growth of what was

apparently crown-gall on an upper root. The root systems of all four trees were healthy; there were not even any of the surface roots with browned centers, as observed in other trees.

It does not appear that winter injury to the roots can be associated, even as a contributory factor, with the occurrence of die-back and rosette. Further, manifestations of root injury, as observed in this locality in 1914 and 1915, are quite different. In severe cases the leaves wither and die before they have attained much size, and usually certain large branches die throughout their length; but there is no condition like die-back or rosette.

An unhealthy condition of the roots is, apparently, not necessary to the presence of the disease. Allen (1) has made a study of the condition of the roots of apple trees in the Hood River valley, noting, among other things, the relation of root condition to the occurrence of " fruit-pit," and " winter injury " or " die-back." (These troubles may be similar to the drouth spot and die-back of the Champlain valley.) He states: " The presence of ' fruit-pit ' was found to be worse under the worst conditions of the soil, and upon trees having root systems in the most critical condition. *In less serious conditions of soil the roots of the ' pit trees ' were either normal in vigor or nearly so.*

" Winter injury appears to be most prevalent on soils of poor condition, but no relation was found to exist between the seriousness of the trouble and the condition of the roots of the trees; the roots of some trees so affected, however, were found to be in very poor condition."

FRUIT-PIT OR STIPPEN.

Various theories to account for fruit-pit or stippen formation have been advanced by different workers. Only those which assign a so-called physiological cause will be reviewed here. Other causes have been suggested, but there is no evidence in favor of them. Such are parasitic fungi, insects, mechanical injury, spray injury.

Wortmann (25) believes the injury to be due to an increased concentration of the cell sap through water lost by transpiration. Excessive transpiration and poor conduction of water from cell to cell are thought to be the factors most concerned. From a study of several varieties susceptible and not susceptible to stippen, Wortmann finds that, in general, non-susceptible varieties have thicker walled, smaller epidermal cells, and fewer stomata or other openings in the cuticle. He considers this a protection against transpiration.

Zschokke (26) comes to much the same conclusion as Wortmann. He emphasizes the factor of irregular conduction from cell to cell and connects the occurrence of the spots in larger numbers near the calyx end of the fruit with the larger number of stomata and other openings in that region, and with a possible higher rate of transpiration by the upper one-third of the apple.

Sorauer (24) suggests that stippen is caused by too rapid maturation of individual cell groups. In every fruit the tissue is unequally filled with reserve materials. Untimely dryness of the soil may interfere with the amount of organic material necessary to the full development of the fruit. Individual tissue groups will be especially poor in contained material and will mature (ausleben) more quickly.

Evans (9) offers the following theory: Abundant transpiration and copious absorption of the water by the roots occurs, as on a warm, bright day. The transpiration is suddenly checked, without a corresponding check in absorption. The cells of the flesh in proximity to the fibro-vascular bundles become gorged, distended with water, burst and die. Adjacent cells, being dependent on these for their water supply, also die, producing small brown areas in the flesh of the fruit. The conductive tissue is not affected, since it is strong walled and adapted to withstand pressure.

McAlpine (13) disagrees with Evans on the following grounds: (1) The cells of the flesh are closely pressed together and could not burst; (2) if thin slices of the "pitted" portions of the fruit are placed in water the cells regain their original size; (3) it is very easy to rupture the cell walls in the process of preparing sections; (4) the well known water-core disease is generally conceded to be due to a superabundance of water which passes through the cell walls under pressure, fills the intercellular spaces, driving out the air and causing the water-soaked appearance. In a later report he suggests that sometimes bursting of the cells from turgor may cause the disease. (McAlpine [16]).

McAlpine offers the following to explain the occurrence of "bitter pit" in both a wet and a dry season: The supply of water to the cells is deficient during a critical period of growth. In a wet season the apple grows very rapidly. The network of conductive tissue cannot develop rapidly enough to maintain properly balanced proportions. Thus the water supply becomes deficient. In a dry

season transpiration is excessive and the soil, lacking in moisture, cannot supply a sufficient amount to the fruit, resulting in a drying of the cells, particularly those at the surface.

"Confluent bitter pit" or "crinkle" is thus explained by McAlpine: Excessive transpiration caused by sudden heat, combined with rapid growth which produces partial rupture of the epidermis, may result in the vascular network not being formed over large areas. These may develop "confluent bitter pit."

McAlpine attributes the greater amount of stippen at the calyx end of the apple to the greater transpiration which takes place in that region. He assumes this greater transpiration since the number of stomata at that end is about three times the number at the opposite end.

According to McAlpine, interior stippen not related to external lesions (the cork of Clinton county) may be explained in one of two ways: (1) The spots appeared when the apples were very small and were later enclosed by the growth of the flesh; or (2) the injury progressed inward from external spots following the conductive tissue.

DROUTH SPOT AND CORK.

Chandler (5) has shown that under conditions of reduced water supply to the roots, and increased transpiration, the leaves of an apple tree may rob the green fruit of its water, causing it to wilt. This is due to the fact that the cell-sap concentration in the leaves is somewhat higher than in the green fruit. Hence, the direction of the osmotic flow would then be from the fruit to the leaves. It seems probable that, if the cork and drouth spot are due to a combination of reduced water supply and excessive transpiration, they are caused in this manner, rather than by an excessive transpiration of the fruits themselves.

RELATIVE RATE OF TRANSPIRATION OF YOUNG FRUITS AND LEAVES.

The measurement of the rate of transpiration of fruits while attached to the tree cannot be accomplished with any degree of accuracy. McAlpine (14) has measured the amount of water given off by apples enclosed in glass bulbs attached to the tree. His results show an increase in the amount of water transpired as the fruit increases in size. Unfortunately, it cannot be said whether this increase is relative as well as absolute; that is, whether there

is an increase or decrease in the amount of water transpired per unit weight of fruit. There seems to be no good method of determining this. It was thought something might be learned from the measurement of the amount of water given off by detached fruits. For this purpose fruits were removed from the tree and the ends of their stems paraffined. They were weighed immediately, and subsequently at intervals of twenty-four hours. For purposes of comparison detached leaves were similarly treated. The results are given in Tables II and III.

TABLE II.—AMOUNT OF WATER TRANSPIRED FROM YOUNG DETACHED APPLE FRUITS.

Date	Variety	Number of fruits	Transv. diam. of fruits	Average weight of fruits	Water transpired; measured in grams per kilogram of green weight per hour			
					24 hrs.	48 hrs.	72 hrs.	96 hrs.
1916			*Mm.*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
June 13	Fameuse...	25	8-12	0.837	2.33	4.72	4.45	......
	McIntosh...	25	11-15	1.45	.918	1.35	1.51	......
June 17	McIntosh...	25	15-20	3.19	.....	1.03	1.23	......
June 22	McIntosh...	25	20-25	6.06	.959	.979	.934	......
June 29	McIntosh...	10	25-30	14.89	.403	.627	.....	......
1915								
June 25	McIntosh...	10	......	10.66	.....	.665	.....	0.811
	N. Spy.....	10	......	7.38	.....	.845	.....	.992
	Fameuse...	10	......	8.74	.....	.645	.....	.637
June 29	Baldwin....	10	......	7.56	.782	.703	.632	......
	R. Island...	10	......	9.35	.784	.717	.641	......
	N. Spy.....	10	......	9.51	.981	.870	.771	......
	Fameuse...	10	......	8.62	.817	.725	.641	......
June 30	McIntosh...	10	......	9.73	.856	.893	.690	......
	Baldwin....	10	......	31.68	.197	.162	.133	......
	R. Island...	10	......	35.56	.154	.130	.126	......
July 16	McIntosh...	10	......	42.26	.244	.210	.163	......
	Fameuse...	10	......	29.62	.162	.247	.191	......

It will be seen that the amount of water vapor given off by detached fruits does not vary so much with variety as with the size of the fruit; also, that the amount transpired per unit of green weight is not large, even in the very young fruit, and decreases as the fruit grows. While the above figures must not be taken as representing the rate of transpiration in fruits attached to the tree, yet it may be assumed that the same relation holds in the latter case. This is not surprising. When the apple is very small the

stomata are abundant on its surface. As the apple grows its surface area increases without a corresponding increase in the number of stomata. Lenticels and other openings in the skin may appear, but in a large apple the number of openings per unit of surface is greatly less than in the very young fruit.

TABLE III.—AMOUNT OF WATER TRANSPIRED FROM DETACHED APPLE LEAVES.

Date	Variety	Number of leaves	Water transpired; measured in grams per kilogram of green weight per hour		
			24 hrs.	48 hrs.	72 hrs.
1916			*Grams*	*Grams*	*Grams*
June 13	Fameuse	50	6.85	7.80	6.49
	McIntosh	50	7.39	5.61	5.49
June 17	McIntosh	50	....	5.31	5.05
June 22	McIntosh	50	8.29	6.68	5.75
June 29	McIntosh	50	8.83	8.13	....
1915					
June 30	Northern Spy	20	11.82	9.03	6.65
	Fameuse	20	11.16	8.63	7.22
	McIntosh	20	12.81	9.24	6.50
July 14	Baldwin	20	8.03	6.87	6.00
	Rhode Island	20	8.36	7.30	5.55
July 16	McIntosh	20	9.19	7.61	5.63
	Fameuse	20	10.92	8.59	5.83

It will also be seen that the amount of water given off by detached leaves is much greater than that transpired by the fruits. Undoubtedly, this relation also holds true on the tree. It is an accepted fact of physiology that a plant's leaves are its chief organs of transpiration.

EXPERIMENTAL PRODUCTION OF LESIONS RESEMBLING THOSE OF DROUTH SPOT.

Chandler (5) employed a unique method to demonstrate the ability of the leaves to rob the fruit of water. Twigs bearing green fruits and leaves were detached from the tree, the cut ends of the twigs and the fruits were dipped in melted paraffin at a temperature low enough not to injure the tissue. These twigs were then placed in a cool, dark place where transpiration would not be excessive. It was found that the fruits wilted and shrunk inside the paraffin, while the leaves remained quite fresh.

It seemed that by employing this as a method of rapidly wilting the fruits it might be possible to produce lesions resembling those of drouth spot. A large number of tests of this sort were made in 1915 and 1916. The tests of 1915 were not so uniformly successful as those of 1916, since some time was spent in determining the proper relation of number and size of the leaves to the fruits tc obtain best results. However, some success was met with in both seasons. It was found that with fruits up to 2.5 centimeters in. diameter, a fruit spur bearing from one to three fruits (according to the number and size of its leaves) gave the best results.

In the beginning of the experiments the following checks were employed: (1) A twig with leaves removed and the cut ends of the twig and the fruits dipped in paraffin; (2) a twig with leaves and fruit attached, the cut end of the twig being paraffined; (3) detached fruits, with the ends of the stems paraffined. Since the fruits in the case of check 1 did not wilt, only checks 2 and 3 were employed in later experiments; and, finally, since the detached fruits did not wilt perceptibly during the period of the experiment, this check, also, was discontinued. In the case of check 2, leaves and fruit attached and the cut end of the twig paraffined, wilting of the fruits occurred, though perhaps not so rapidly as in the case of twigs with paraffined fruits. For some reason, lesions never developed on fruits from these check twigs. After being prepared the twigs were placed in a cool, dark place for a variable period, (from 12 to 24 hours) until they had wilted to a certain point which was learned by experience to yield the best results. The paraffin was then removed from the fruits, the ends of the twigs freshly cut and placed in water. Except in the case of large fruits it was always possible to bring the fruits back to their original state of turgor.

The lesions began to be apparent a short time after the removal of the paraffin, or as soon as the dead tissue became oxidized, but they showed most plainly after the fruits had again become turgid.

In 1916, 11 of these wilting experiments were made, involving in all 283 twigs and 449 fruits. Of these, 281 fruits developed lesions resembling those of drouth spot, and varying in type from superficial to deep seated; 168 fruits failed to show any injury whatever. The experiments were more uniformly successful with the smaller fruits. It was not attempted to conduct any experiments

with fruits larger than three and one-half centimeters in transverse diameter. The more rapid and severe the wilting the more the resulting injury resembled the deep-seated type of spot, such as was common in 1915. Less rapid and less severe wilting caused spots resembling the superficial type of lesion.

These spots of course resembled the early types of the disease since it was not possible to cause the fruits to grow subsequent to the injury. They bore the same relation to the vascular system of the fruit as in the case of natural injury. In a very few cases internal spots developed, with no external abnormality, thus resembling the cork more than the drouth spot. Plate XXI is a photograph of some fruits in which the injury had been produced experimentally.

Histology of artificial lesions.—Microtome sections were made of some of the artificially produced spots, and these were studied in comparison with those from naturally diseased fruits. They were found to correspond with them in respect to the tissues affected, the relation of the dead spots to the vascular system, and in the nature of the injury to the cells. Figures 1 and 2 of Plate XXIX are drawings made from sections of artificially produced lesions. They should be compared with Plate XXII, fig. 2, and Plate XXIII, fig. 1.

ATTEMPT TO PREVENT DROUTH SPOT BY REMOVAL OF FOLIAGE.

It seemed possible that the reduction of the leaf surface of the tree during the critical period might operate to prevent the injury. A tree was selected in one of the "sick" parts of orchard No. 1 and on June 9, 1916, a number of its leaves were removed, reducing the total area of leaf surface by about one-third. The tree chosen was affected with die-back and had borne diseased apples in past years. At this date its crop was healthy, though one of the nearby trees bore diseased fruit. On June 20 twelve diseased fruits were found on this tree and on June 26 five more. These were removed and no disease developed subsequently. The remainder of the crop of this tree was healthy. On several of the surrounding trees the greater part of the crop was diseased, and on these trees also the disease developed rather late, a very few freshly diseased fruits being found as late as July 5. Too much must not be inferred from the result of this defoliation, as only one tree was involved, and it was possible to find several trees equally affected with die-

back in which no disease developed in 1916. In any event, reduction of the leaf surface of a tree could hardly be adopted as a control measure against drouth spot.

ATTEMPT TO CAUSE DROUTH SPOT BY OBSTRUCTING THE SAP FLOW.

It seemed possible that an obstruction to the sap flow might produce the disease. The writer has observed apples affected by the true fruit-pit, or stippen, on a branch partially girdled by a Sphaeropsis canker, the fruit on the other branches of the tree remaining healthy. On June 9, 1916, five branches were selected on five healthy trees in orchard No. 1, and notched deeply through the bark and outer sapwood on opposite sides, below the fruit-bearing portion. The disease did not develop on these branches or on any other branches of these trees.

CONCLUSION AS TO CAUSE.

These apple diseases must be considered of non-parasitic nature, and greatly influenced, if not caused, by lack of sufficient moisture Brooks and Fisher (3) state that the corky pit or drouth spot of the Northwest is caused directly by drouth, and that the disease has been produced experimentally by subjecting Winesaps to sudden drouth. Allen (1) says: "much of the fruit-pit and winter-injury now so prevalent in the orchards [of the Hood River Valley] is due to drouth and improper fertilization."

The writer's observations of the cork and drouth spot of the Champlain Valley indicate an insufficient supply of water from the roots as one of the chief causal factors. Since, however, in a wet season, and under conditions where there seems to be no deficiency of moisture, these diseases may occur in trees that have been previously diseased; and since there is a tendency for certain trees to become diseased year after year, insufficient soil moisture cannot be looked upon as the sole cause. Some not thoroughly understood factor or factors must operate to produce the disease under these conditions.

Finally, it is suggested that the exact manner of occurrence of the injury may be by the leaves robbing the fruit of water during a critical period of low root supply and high transpiration. Rapid wilting of the fruits can be brought about by excessive transpiration from the leaves. It has been seen that this wilting may result

in the death of certain cells near the vascular bundles, forming lesions resembling those of drouth spot, and occasionally, of cork, Chandler (5) has presented evidence that transpiration from the leaves may bring about a scarcity of water in the fruit under field conditions. It is not impossible that this is at least one of the ways in which the disease may be caused.

This seems more likely than that the injury is due to an excessive transpiration from the fruit itself, or, as suggested by McAlpine for "crinkle," to the failure of the vascular network over large areas. The striking thing about these diseases is the presence, not the absence, of meshes of this vascular network in close proximity to the dead cell areas.

In making the above suggestion as to the cause of cork and drouth spot, the writer realizes that the small amount of experimental work done does not warrant a definite conclusion. There is, undoubtedly, much yet to be learned of the real nature of these diseases.

Further, it is not intended to advance this theory to explain the cause of true fruit-pit, or stippen, which occurs in a late stage of the fruit's growth and is said to develop in storage (McAlpine [12], [13], [15]).

CONTROL.

The most promising outlook for the control of drouth spot and cork seems to be in methods of conserving soil moisture and improving the water-holding capacity and physical condition of the soil. Clean cultivation, alone, is not effective. Perhaps clean cultivation combined with leguminous cover crops may accomplish more.

There seems to be a slight indication of the beneficial effect of a vetch-and-buckwheat cover crop in orchard No. 1 in 1916. A part of this orchard which had been badly affected with drouth spot in the past was practically free from it in 1916. This part of the orchard was clean-cultivated in 1915 and sowed to a cover crop of vetch and buckwheat. It is possible, also, that there are some indications in the case of the Stevens orchard at Orwell, Vermont, where a small area bearing sweet clover was continuously free from drouth spot, while clean-cultivated areas of the same soil type exhibited the disease. Also, in this orchard clean cultivation with seeding to alfalfa in 1915 was followed by an almost

complete absence of the disease in 1916. Too much must not be assumed from the latter circumstance in view of the rainy spring and the very inconsiderable amount of drouth spot throughout the Champlain valley that season. The chief reason for suggesting the use of leguminous cover crops lies in beneficial results reported from the Pacific Northwest. Allen (1) believes the "fruit-pit" and "winter injury" to be largely due to drouth conditions and improper fertilization, and says: "This statement appears to have been borne out during the past two years by the rapid disappearance of fruit-pit and winter injury following the application of irrigation and the use of leguminous crops in the orchards." Clawson (6) offers the use of a leguminous crop, preferably alfalfa, as a positive remedy for rosette in Washington orchards. It is claimed that two or three years' growing of alfalfa in an affected orchard results in the disappearance of the trouble.

The benefits derived from alfalfa are probably due to an improvement in the physical condition of the soil, resulting in a better water-holding capacity, and the addition of nitrogen. During the first two years alfalfa probably makes a large drain on the soil moisture, but it is a deep-rooted plant and after becoming established obtains its water largely from lower levels, and further acts beneficially by shading the soil. According to Clawson (6) the best method of alfalfa culture in the orchard would be a constant disking in of the alfalfa tops forming a vegetable mulch over the soil surface. The common practise with Washington growers is to cut two or three crops for hay and disk in the late growth the following spring. In some orchards the alfalfa has been grown continuously without harvesting, with good results. Clawson recommends that the alfalfa should not be planted before the orchard is five years old, and that it be then started in the centers of the rows, leaving, at first, a cultivated strip next to the trees. When the water supply is short it may even be advisable to plant the alfalfa in drills, allowing for cultivation between.

The conditions in the Champlain valley cannot be identical with those in the Northwest, for irrigation is not practised; but it seems possible that there may be some benefit obtained from the use of a leguminous cover crop or even continuous alfalfa culture in the orchard. Both these practises are being tried in two of the orchards which have been studied; a few years' observation will tell the result.

Cork, as occurring independently of drouth spot, has a tendency to be restricted to certain trees year after year. Some growers claim to have changed this habit of a tree for a period of years by very severe pruning. Perhaps in many cases the removal of certain "corky" trees would be advisable, since, usually in a well-cared-for orchard, the number of trees predisposed to cork is not large.

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EXPLANATION OF PLATES.

PLATE XVIII.— CORK DISEASE OF APPLES.

Fig. 1. Surface and cross-section views of young Fameuse apples affected with cork. Fruits smooth externally. Photographed July 29, 1916. Natural size.

Fig. 2. Fameuse apples (nearly mature) affected with cork. The cut fruits show spots of cork scattered all through the flesh. The surface of the uncut fruit is covered with shallow depressions. Photographed September 6, 1916. Natural size.

PLATE XIX.— YOUNG APPLES AFFECTED WITH DROUTH SPOT.

Fig. 1. Superficial type of drouth spot. The fruit in the upper left hand corner has an older injury than the others and has shrunk somewhat. Hence, the extremely wrinkled appearance. Probably, this fruit, in cross section, would show a few brown spots in the flesh. The cross sections shown are of fruits similar to the three right-hand fruits in the top row. Note that the trouble is only skin deep. Three healthy fruits (in the center) are shown for comparison. Photographed June 19, 1916. Natural size.

Fig. 2. Young McIntosh fruits affected with drouth spot. The lesions are of the deep-seated type common in 1915. Photographed in June, 1915. Natural size.

PLATE XX.—DROUTH SPOT OF APPLES.

Fig. 1. Cross sections of fruits similar to those shown in Plate II, fig. 2. Note the relation of the corky spots and cavities to the main vascular branches. The fruit in the upper right hand corner is healthy. Photographed in June, 1915. Natural size.

Fig. 2. Half-grown fruits affected with drouth spot. The fruit in the lower right hand corner shows deep-seated lesions as they appear on fruits of this size. The middle fruit in the lower row shows spots of the superficial type with wrinkles in the skin. The other fruits show the cracked and corky appearance of the skin which occurs when the fruit grows subsequent to drouth spot injury. Photographed in July, 1914. Natural size.

PLATE XXI.— APPLES WITH ARTIFICIALLY PRODUCED LESIONS RESEMBLING DROUTH SPOT.

Variety, McIntosh. Photographed June 19, 1916. Natural size. Compare with Plate XIX and Plate XX, fig. 1.

PLATE XXII.— PATHOLOGICAL HISTOLOGY OF CORK AND DROUTH SPOT.

Fig. 1. Drawing of an internal brown spot of cork. The dead cells are indicated by heavy stippling. The healthy cells are shown in outline only. Note the ladder-like arrangement of healthy cells next to the diseased area. Outlined with the aid of a camera lucida. × 50.

Fig. 2. Cross section through a drouth spot of the superficial type with smooth surface. The dead cells in the hypodermal parenchyma are indicated by heavily stippled contents. Outlined with the aid of a camera lucida. × 215.

PLATE XXIII.— PATHOLOGICAL HISTOLOGY OF DROUTH SPOT.

Fig. 1. Cross section through drouth spot on very young apple. Dead cells are distingnished by heavy stippling of the contents. In this case the disease affects the whole of the hypodermal parenchyma and in places extends into the cortex. Outlined with the aid of a camera lucida. × 100.

Fig. 2. Cross section through a late stage of drouth spot, superficial type, showing layers of rectangular cells laid down preliminary to cutting off the dead area by means of a cork layer. One or two of the outer layers of rectangular cells have suberized

1

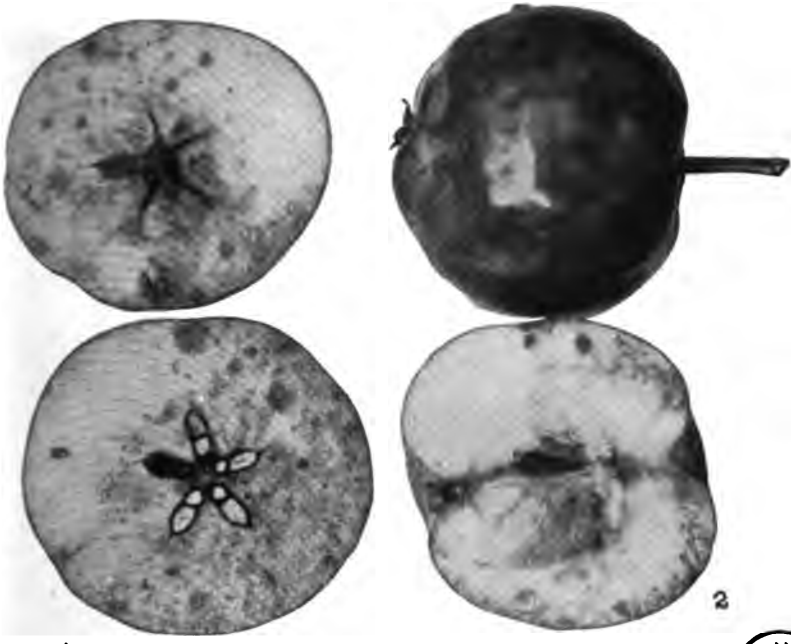

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PLATE XVIII.— CORK DISEASE OF APPLES.
(For explanation, see p. 204.)

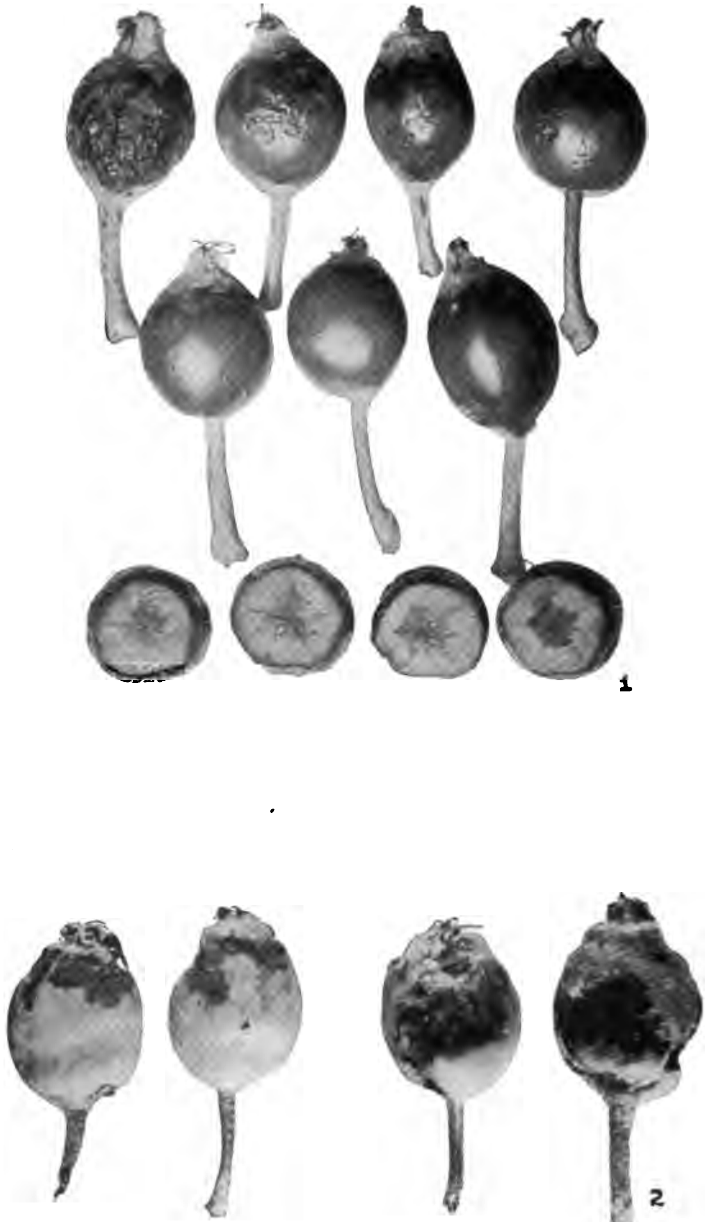

Plate XIX.— Young Apples Affected with Drouth Spot.
(For explanation, see p. 204.)

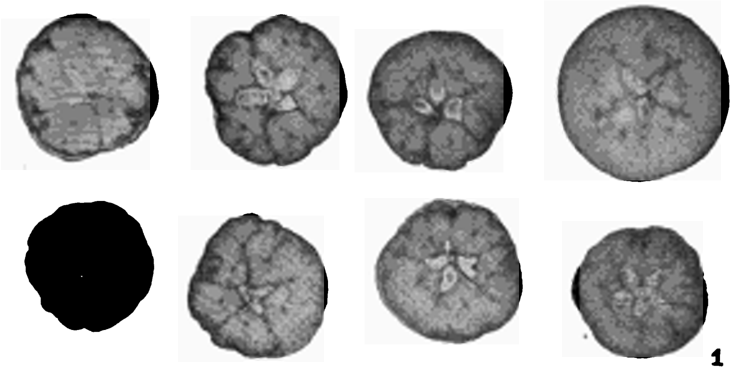

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Plate XX.— Drouth Spot of Apples

(For explanation, see p. 204.)

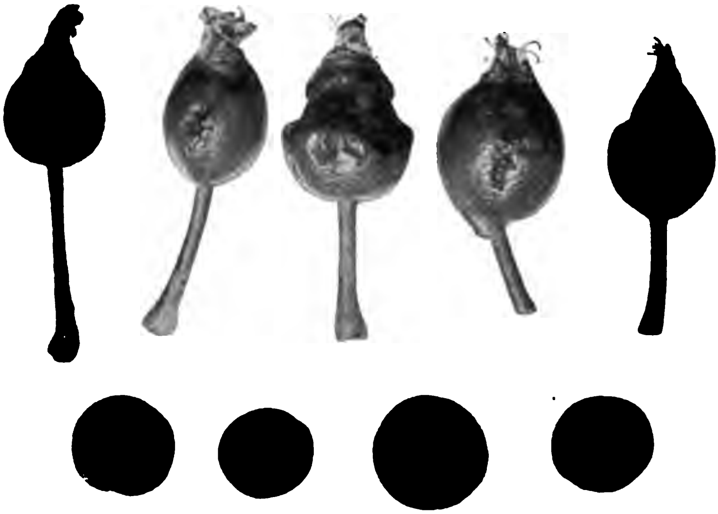
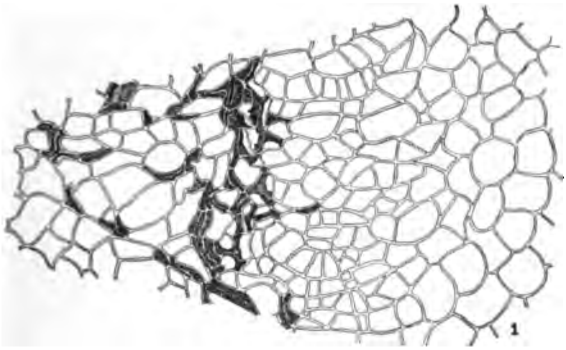


PLATE XXI.— APPLES WITH ARTIFICIALLY PRODUCED LESIONS RESEMBLING DROUTH SPOT.

(For explanation, see p. 204.)



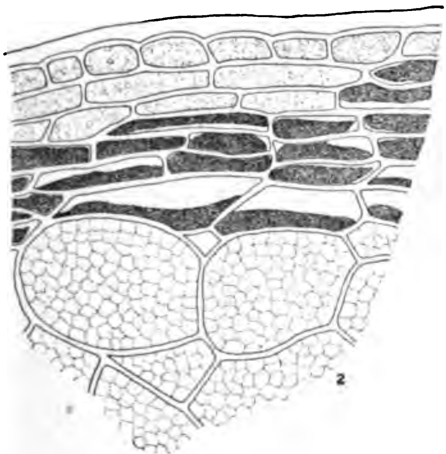


PLATE XXII.— PATHOLOGICAL HISTOLOGY OF CORK AND DROUTH SPOT.

(For explanation, see p. 204.)

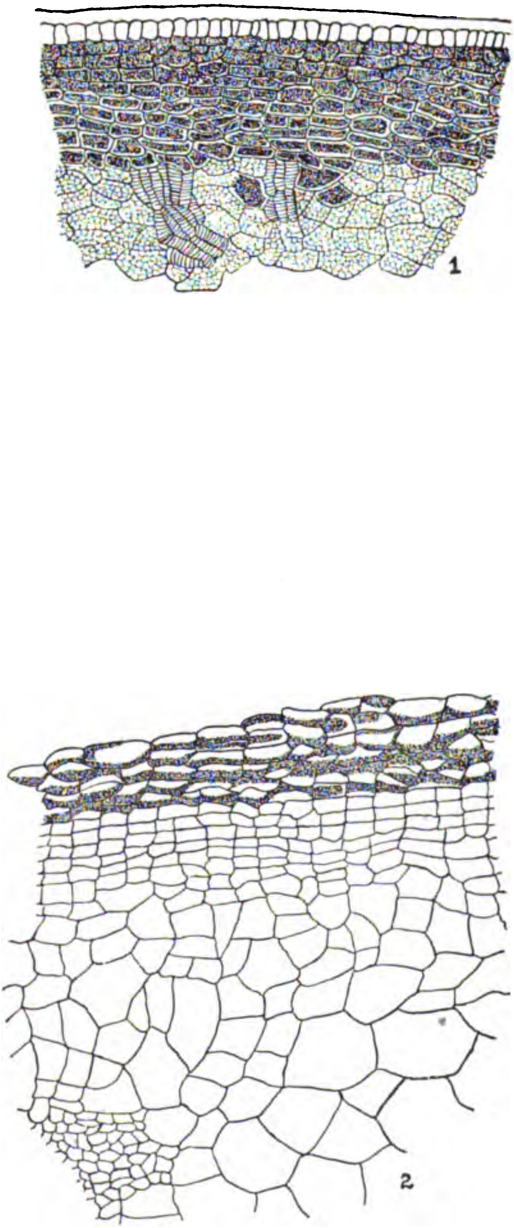
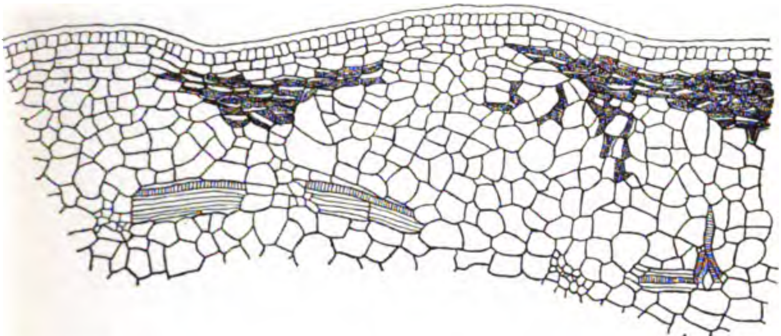


Plate XXIII.— Pathological Histology of Drouth Spot.

(For explanation, see p. 204.)



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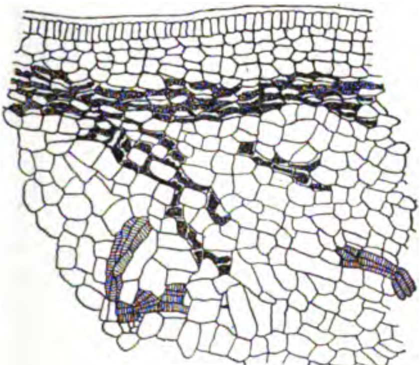

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Plate XXIV.— Pathological Histology of Drouth Spot.
(For explanation, see p. 205)

PLATE XXV.— DROUTH DIE-BACK OF APPLE TWIGS.
(For explanation, see p. 205.)

PLATE XXVI.— DROUTH DIE-BACK OF APPLE TWIGS.
(For explanation, see p. 205.)

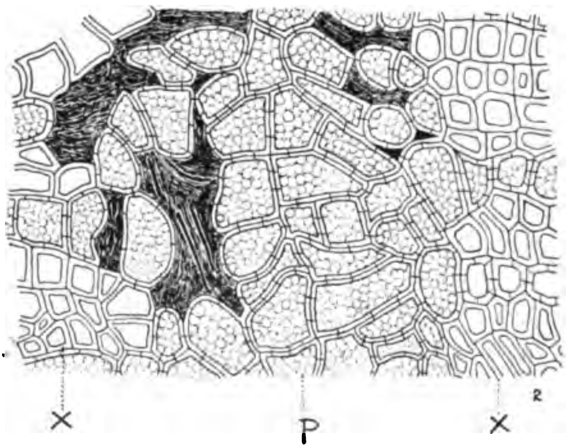
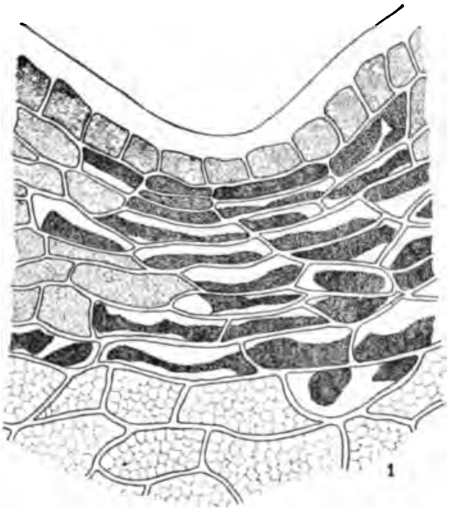


Plate XXVII.— Drouth Die-back of Apple Twigs.

(For explanation, see p. 205.)

PLATE XXVIII.— DROUTH DIE-BACK AND DROUTH ROSETTE OF APPLE TREES.

(For explanation, see p. 205.)



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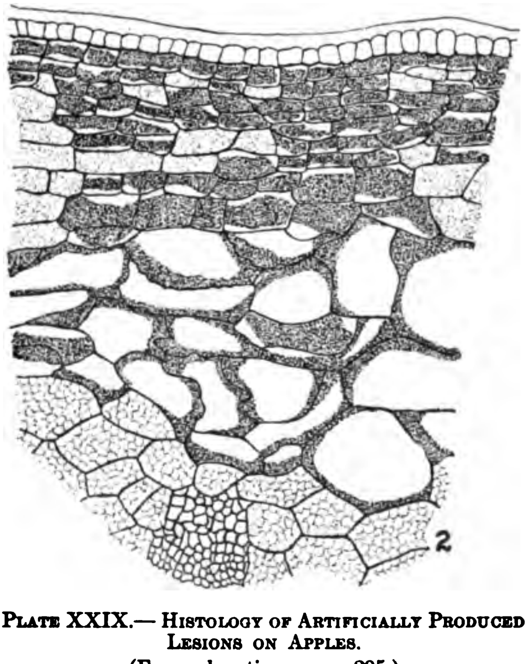

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PLATE XXIX.— HISTOLOGY OF ARTIFICIALLY PRODUCED LESIONS ON APPLES.

(For explanation, see p. 205.)

cell walls. Dead cells of the hypodermal parenchyma are shown by dark stippling of the contents. The epidermis has peeled off. Contents of healthy cells not shown. Outlined with the aid of a camera lucida. × 100.

PLATE XXIV.— PATHOLOGICAL HISTOLOGY OF DROUTH SPOT.

Fig. 1. Cross section through superficial drouth spot showing wrinkles in the skin. Dead cells shown by dark stippling of the contents; contents of healthy cells not shown. Note that the dead areas occur in the hollows; also, their relation to the vascular system. Outlined with the aid of a camera lucida. × 67.

Fig. 2. Cross section through a drouth spot in which the dead area is mostly in the tissue transitional between hypodermis and cortex. Note the relation of the vascular branches. Outlined with the aid of a camera lucida. × 67.

PLATE XXV.— DROUTH DIE-BACK OF APPLE TWIGS.

Die-back twigs of the previous season with laterals from the base bearing clusters of dwarfed, linear lanceolate leaves. Photographed in July, 1915.

PLATE XXVI.— DROUTH DIE-BACK OF APPLE TWIGS.

Die-back twigs of the previous season being renewed by healthy laterals from the base. Photographed in July, 1915.

PLATE XXVII.— DROUTH DIE-BACK OF APPLE TWIGS.

Fig. 1. A severely affected tree in orchard No. 1 with the diseased branches removed. This tree was dug up in June, 1915, for an examination of its roots which were found to be healthy. (See page 509.) Photographed in June, 1915.

Fig. 2. Cross section through a die-back twig showing zone of parenchyma wood, *p*, between two layers of normal wood, *x x*. The brown discolored areas occupied by intercellular substance are indicated by dark shading. Outlined with the aid of a camera lucida. × 280.

PLATE XXVIII.— DROUTH DIE-BACK AND DROUTH ROSETTE OF APPLE TREES.

Affected trees in orchard No. 1. Photographed in July, 1916.

PLATE XXIX.— HISTOLOGY OF ARTIFICIALLY PRODUCED LESIONS ON APPLES.

Fig. 1. Cross section through an artificially produced lesion resembling drouth spot. Outlined with the aid of a camera lucida. × 215. Compare with plate V, fig. 2.

Fig. 2.— Cross section through an artificially produced lesion resembling drouth spot. Outlined with the aid of a camera lucida. × 100. Compare with Plate VI, fig. 1.

LIME-SULPHUR VS. BORDEAUX MIXTURE AS A SPRAY FOR POTATOES. IV.*

M. T. MUNN.

SUMMARY.

The experiment described in this bulletin is, in the main, a repetition of experiments made in 1911, 1912, 1913 and 1914 and reported in bulletins 347, 352, and 397. The results agree essentially with those previously obtained. They show that lime-sulphur is harmful rather than beneficial to potatoes.

Bordeaux mixture prevented tip-burn to a considerable extent, made the foliage darker green, prolonged the period of growth, increased the yield, and materially checked the ravages of late blight caused by the fungus *Phytophthora infestans.*

Lime-sulphur, on the contrary, aggravated tip-burn, dwarfed the plants, shortened the period of growth, reduced the yield, and proved valueless as a preventive of late blight.

In this five-year series of experiments the average increase in yield due to spraying with bordeaux mixture is 68.6 bushels of marketable tubers per acre; while the average *decrease* in yield due to spraying with lime-sulphur solution is 25.8 bushels of marketable tubers per acre.

INTRODUCTION.

Experiments made at this Station in 1911, 1912, 1913 and 1914 demonstrated the great superiority of bordeaux mixture over lime-sulphur as a spray for potatoes. The results of these experiments were so striking as to leave little doubt that lime-sulphur is not to be recommended for use on potatoes. Nevertheless, it was deemed advisable to repeat the experiment in 1915, because of the uncertainty concerning the value of lime-sulphur as a preventive of late blight (*Phytophthora infestans*) and the rot which follows it. In the experiments in 1911, 1913, and 1914 there was neither late blight nor rot. In the 1912 experiment there was a light attack of blight followed by much rot, but as many plants in the lime-sulphur rows were already dead when the blight appeared no data on the fungicidal value of the lime-sulphur were obtained.

* A reprint of Bulletin No. 421, May, 1916.

Jones and Giddings,[1] Greene and Maney,[2] and Macoun,[3] report experiments in which lime-sulphur proved beneficial to potatoes. In the Iowa experiment, lime-sulphur solution proved to be a better spray than the bordeaux mixture. Clinton[4] states that, in Connecticut, in a season with a little injury from blight late in the season, spraying potatoes with commercial lime-sulphur did not prolong the life of the vines or give increased yields, while spraying with bordeaux mixture did. Pethybridge[5] has reported the results of an experiment in Ireland in which three applications of lime-sulphur solution proved utterly useless as a preventive of blight and rot. Melhus,[6] using the method elaborated by Reddick and Wallace,[7] made some studies of the fungicidal value of commercial lime-sulphur and found that a 1-to-21 solution was necessary to prevent the germination of the spores of the late-blight fungus. Similar tests made by the writer using the glass-slide method indicated that 1-to-40 lime-sulphur had but little toxic effect upon the germination of Phytophthora spores. However, different results might be secured in the field since Morse[8] and others have noted that laboratory experiments may fail to show such high fungicidal properties for certain compounds as are indicated by field experiments.

THE EXPERIMENT IN 1915.

PLAN, METHODS, AND MATERIALS.

The plat of land devoted to the experiment in 1915 was 290 by 45 feet. It contained 15 rows, each having an area of one-fiftieth acre. The fifteen rows were divided into five series with three rows in each series. Other rows of potatoes on each side of the plat made special outside rows unnecessary. Row No. 1 of each series was sprayed with bordeaux mixture, Row No. 2 with lime-sulphur, while Row No. 3 was reserved as a check.

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[1] Jones, L. R., and Giddings, N. J. Vt. Sta. Bul. 142: 112–114. 1909.
[2] Greene, L., and Maney, T. J. Iowa Sta. Bul. 149. 1914.
[3] Macoun, W. T. Report of the Dominion Horticulturist. Rpt. of Experimental Farms, Canada, 1913, p. 303.
[4] Clinton, G. P. Report of the Station Botanist 1909–1910. Conn. Sta. Rpt. 1909–1910: 743. 1911.
[5] Pethybridge, G. H. Investigations on Potato Diseases (Third Report). *Jour. Dept. Agr. and Tech. Instr. Ireland* 12: 339. 1912.
[6] Melhus, I. E., Wis. Sta. Research Bul. 37: 44–46. 1915.
[7] Reddick, D., and Wallace, E. *Science*, n. s. 31: 798. 1910.
[8] Morse, W. J. *Phytopathology* 6: 118. 1916.

The potatoes were of the variety Sir Walter Raleigh, and the seed pieces were placed fifteen inches apart by the use of gage-rods.

On July 3 when the plants were about 8 inches high, the first application of the spray solutions was made, using the 6–6–50 bordeaux mixture and the 1-to-40 lime-sulphur solution. To control the " bugs " six pounds of arsenate-of-lead paste was added to each fifty gallons of spray mixture used in the second application on July 19. On the same date the check rows were treated with the same amount of arsenate of lead in water with equally good results.

The spray solutions were applied every two weeks. A knapsack sprayer was used and the solutions applied very thoroughly at the rate of 150 to 200 gallons per acre in each application. Five applications were made to the bordeaux rows, and four to the lime-sulphur rows.

EFFECT OF THE SPRAY MIXTURES ON THE FOLIAGE AND THE BLIGHT.

On July 27, following approximately three weeks of fairly cool and exceedingly rainy weather, two plants showing the late-blight fungus were found in the experimental plat. The number of infected plants did not materially increase until about August 4 when, following another period of very rainy weather, the fungus spread very rapidly over the field. The disease was confined almost entirely to the lime-sulphur and unsprayed rows. The bordeaux-sprayed rows showed only an occasional blighted leaf on the lower branches.

On August 16, at the time of the fourth spraying, the bordeaux rows were holding heavy green foliage and showed only an occasional blighted leaf. The plants in the lime-sulphur and unsprayed rows were badly blighted. So many were dead that only a small amount of lime-sulphur solution was required to cover the living plants in these rows. On August 24 the lime-sulphur and unsprayed rows were completely dead from the attacks of the blight fungus. At no time was it possible to detect any fungicidal value from the lime-sulphur solution; that is to say, the lime-sulphur rows appeared to suffer from the blight to the same extent as did the unsprayed rows. The bordeaux-sprayed rows were put to a severe test since many of the blighted plants in the adjoining rows were in contact with plants in these rows. In fact many of the blighted plants had fallen among healthy plants in the bordeaux rows. In spite of this condition only a few bordeaux-sprayed plants showed evidences of serious blighting until late in the

PLATE XXX — VIEW FROM WEST END OF EXPERIMENTAL FIELD ON AUGUST 24, 1915.
Lime-sulphur and unsprayed rows dead from blight for several days; bordeaux rows holding considerable healthy foliage.

season when they, also, succumbed to the blight. These rows should have been sprayed every week with bordeaux mixture during this exceedingly favorable blight season instead of every two weeks. If this had been done the writer feels sure that the late blight would have been controlled, since an adjacent plat, more thoroughly sprayed, showed practically no late blight.

Owing to the fact that the late blight appeared in the field and killed the lime-sulphur rows rather early in the season the harmful effects of the lime-sulphur solution were not as apparent as in the previous years' experiments. What appeared to be a weakness of the stems of the lime-sulphur-sprayed plants was evident on August 4 when, following a severe rainstorm, it was observed that the lime-sulphur rows showed considerably more plants blown over than was evident in either of the other rows. These plants regained their upright position much more slowly than did those of the other rows.

A form of leaf injury occurred on the lime-sulphur-sprayed plants after the application of lime-sulphur and arsenate of lead. It was

TABLE I.— COMPARATIVE YIELDS OF POTATOES SPRAYED WITH BORDEAUX MIXTURE AND LIME-SULPHUR DURING 1915.

Row.	Fungicide.	Yield per row.			Computed yield per acre.			
		Large.	Small.	Rotten.	Large.	Small.	Rotten.	Total.
		Lbs.	*Lbs.*	*Lbs.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
1	Bordeaux mixture.	242.5	38.0	2.5	202.1	31.6	2.1	236.3
2	Lime-sulphur.....	147.5	33.5	0.0	122.9	27.8	0.0	150.7
3	Check...........	157.5	40.5	2.0	131.2	33.4	1.6	166.2
4	Bordeaux mixture.	237.5	32.5	3.0	197.9	27.1	2.5	227.5
5	Lime-sulphur.....	130.0	45.0	0.5	108.3	37.5	0.4	146.2
6	Check...........	172.5	41.5	1.0	143.7	34.5	0.8	179.0
7	Bordeaux mixture.	218.0	48.5	1.5	181.6	40.4	1.2	223.2
8	Lime-sulphur.....	135.0	55.5	0.5	112.5	46.2	0.4	159.1
9	Check...........	149.5	55.0	0.5	124.5	45.8	0.4	170.7
10	Bordeaux mixture.	242.5	46.0	1.5	202.1	38.3	1.2	241.6
11	Lime-sulphur.....	135.5	51.0	0.5	112.9	42.3	0.4	155.6
12	Check...........	148.0	52.5	0.5	123.3	43.7	0.4	167.4
13	Bordeaux mixture.	216.0	40.0	2.0	180.0	33.3	1.6	214.9
14	Lime-sulphur.....	125.5	60.0	1.0	104.5	50.0	0.8	155.3
15	Check...........	133.5	38.5	0.7	111.2	32.0	0.6	143.8

Gain from use of bordeaux mixture **65.9** *bushels marketable tubers per acre.*
Loss from use of lime-sulphur **14.6** *bushels marketable tubers per acre.*

observed only on such leaves as showed injury from the attacks of the potato beetles. The injury consisted of a drying and curling of the leaves.

YIELDS.

Table I shows the kind of treatment, also the yield of tubers as determined by carefully sorting and weighing each row separately at the time of digging.

DISCUSSION OF RESULTS.

The following table summarizes the results of the five seasons' tests with lime-sulphur and bordeaux mixture on potatoes.

TABLE II.— SUMMARY OF RESULTS OF FIVE SEASONS' TESTS WITH LIME-SULPHUR AND BORDEAUX MIXTURE ON POTATOES.

	1911.	1912.	1913.	1914.	1915.	Average.
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Gain per acre from use of bordeaux mixture	100.3	48.2	24.8	104.0	65.9	68.6
Loss per acre from use of lime-sulphur	39.5	39.1	19.7	16.0	14.6	25.8

The results obtained during the five years are of a confirmatory character and tend to show that where the productive life of the potato field was continued for a longer length of time than usual a considerable increase in yield resulted. The decrease in yield on the lime-sulphur rows was due to the dwarfing effect of the solution associated with the loss of foliage during the latter part of the season. The factors influencing or causing injury to potato foliage when it is sprayed with lime-sulphur solution are thought to be constant since the injury each season appeared to be similar in character and cumulative regardless of weather conditions. The appearance and behavior of the leaves sprayed with lime-sulphur were not materially different from those described by Safro[1] who experimented with potatoes and other plants in Oregon to ascertain what compounds occurring in lime-sulphur are injurious to foliage. However, in our experiments it was not observed that the old leaves were the most severely injured.

[1] Safro, V. I. Oregon Sta. Research Bul. 2. 1913.

The bordeaux rows held their foliage several days longer than the unsprayed rows and from two to three weeks longer than the lime-sulphur rows; hence the results are very much in favor of bordeaux mixture.

CONCLUSIONS.

The relative efficiency of the two sprays, as far as their effect upon the potato foliage is concerned, can be definitely stated. Bordeaux mixture, because of its beneficial influence upon the leaves, materially lengthens the productive life of the potato plants resulting in a marked increase in yield of tubers.

The results of the past season show very plainly that lime-sulphur, at the dilution used in the experiments, has no value as a preventive of potato late blight. Moreover, it has proven to be injurious to the foliage.

It seems certain, then, that lime-sulphur cannot be used as a potato spray. On the other hand, it pays to spray potatoes with bordeaux mixture because the bordeaux mixture prevents tip-burn, prolongs the life of the plants, and increases the yield in dry seasons, while in wet seasons the protection against late blight with its resulting tuber rot, may result in marked gains.

RECOMMENDATIONS FOR SPRAYING POTATOES IN 1916.

At present, the price of copper sulphate is extremely high,— above twenty cents per pound. This is unfortunate, because it increases greatly the expense of spraying and will deter many potato growers from spraying during the coming season.

Under present conditions the advisability of spraying potatoes with bordeaux mixture is a debatable question. In New York, on the average, one can not afford to expend more than about fifteen dollars per acre for spraying and a good job of spraying must be done if it is profitable at that price.

With spraying materials so expensive, they should be used to the best possible advantage. To this end the writer makes the following recommendations:

(1) Omit the early applications. Use no bordeaux until after August 1. If the weather during August should be very dry spraying may be omitted altogether; but if showers are frequent, and particularly if blight makes its appearance in the vicinity, it will be

advisable to make three or four thorough applications at intervals of seven to ten days. In order that there may be no delay in making the applications when they become necessary, the grower should know where copper sulphate may be obtained on short notice.

(2) Reduce the quantity of copper sulphate in the bordeaux mixture to three pounds in fifty gallons, that is, use the 3–3–50 formula; but if an epidemic of blight threatens return to the stronger formula of 5–5–50.

(3) Use nozzles having a small aperture and maintain high pressure in order to secure thorough distribution of the bordeaux mixture.

Concerning the advisability of using some of the ready-made bordeaux mixtures (of which there are several kinds upon the market) it may be said that their fungicidal value depends upon the copper compounds which they contain, and that the quantity of these is, usually, very small. While appearing to be cheap they are, in reality, very dear. In general, their use is not recommended.

REPORT

OF THE

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TABLE OF CONTENTS.

I. Measurements of soil fertility.
II. Plant food for crops in 1916.
III. Chemical changes in the souring of milk.
IV. Concerning the utilization of inosite in the animal organism:
    I. Concerning the effect of inosite upon the respiratory exchange in the dog.
    II. The effect of inosite upon the metabolism of man.
V. Concerning certain aromatic constituents of urine.

[1] Appointed July 1, 1916.

REPORT OF THE DEPARTMENT OF CHEMISTRY.

MEASUREMENTS OF SOIL FERTILITY.*

W. H. JORDAN.

SUMMARY.

1. Nine unlike soils were brought to the Station in quantity from different parts of the State for the purpose of studying the relation of the various methods of chemical examination to their crop-producing capacity.

2. Vegetation experiments were conducted with these soils in the Station forcing house during two years.

3. The soils were submitted to chemical examination by different methods:

a. Complete analysis.

b. A determination of the material soluble in hydrochloric acid of the specific gravity of 1.115 by the A. O. A. C. method.

c. A determination of the materials rendered soluble by continued leaching for ten days with various solvents, namely, water, N/200 HCl and N/25 HCl.

d. A determination of the soluble material obtained by shaking five hours with various solvents, namely, water, N/200 HCl, and N/25 HCl.

4. These soils showed by the vegetation tests greatly unlike crop-producing capacity, the dry matter produced varying in two years from 161.5 grams per box to 9.4 grams per box.

5. By no one of the methods of chemical examination was there established any relation between the amounts of nitrogen, phosphoric acid and potash, either total or soluble, and crop-producing capacity.

6. There appeared to be some relation between the total soluble matter in the soil and productiveness, to the extent that the two soils giving a very low yield of barley showed greatly less solubility than did the others. This relation, however, was not consistent throughout.

7. The general result of this investigation shows that we are not yet in a position through laboratory methods so far devised to measure the fertility of the soil.

* A reprint of Bulletin No. 424, August, 1916.

INTRODUCTION.

Much investigation has been directed toward the establishment of reliable measurements of soil fertility. Many persons seem to regard it as desirable that this be done in order that there may be determined for any given soil its capacity to sustain plant production and its deficiencies that should be met through the application of fertilizing material. It is not certain, however, that it would be of advantage to farmers, as a rule, to give to them directions for maintaining soil fertility that are worked out without any initiative or effort on their part. It is true that no request is more often made of this Station than to have a sample of soil analyzed in order to determine what fertilizer should be used to supplement its weak places and to what crop, or crops, it is adapted. There seems to be a very widespread impression that it is now possible by laboratory methods to ascertain just what procedure should be adopted in order to increase the crop-producing power of a given field. This impression persists notwithstanding the repeated assertions from scientific sources that no methods of analysis are now known which will give such measurements of fertility as will constitute a safe basis for practice. Notwithstanding all this, it is regarded desirable from the standpoint of the investigator to establish, if possible, some relation between laboratory results and field results. It was for the purpose of getting additional light in this direction that the investigation herein reported were outlined.

PLAN OF WORK.

The plan adopted in this investigation was to secure, from different parts of the State of New York, a sufficient quantity of unlike soils to enable production experiments to be conducted with each soil in connection with elaborate chemical studies. In pursuance of this plan, the following soils were secured. For the collection and shipment of four of these soils, I am indebted to Professor J. A. Bonsteel. The chemical work involved in this investigation was performed by E. B. Hart and E. L. Baker.

The following is a description of the soils used so far as it is possible to give it, the descriptions for the first three and fifth being furnished by Professor Bonsteel:

No. 1894.—A brown or yellow sandy loam, six to ten inches deep, resting on yellow or gray sandy loam and gravel. It contains flat shale and a few glacial erratics. It is of glacial origin. It is

a good soil for corn, oats and potatoes. It is found in Chautauqua and Tompkins counties. The sample was collected on the farm of D. H. Hopkins, four miles northwest of Ithaca, N. Y. The field was corn stubble, fertilized the previous year with fifteen loads of sheep and hog manure per acre. No commercial fertilizer was used. The rotation that was followed was corn, oats, wheat, followed by seeding to grass. The sample consisted of the light brown, gravelly, sandy loam taken to a depth of eight inches.

No. 1895.—A brown, silty loam, ten inches deep, resting on a heavy yellow or mottled gray and yellow silt loam, having a depth of two feet; this, in turn, resting on shale and sandstone rock. Soil and sub-soil contain very large amounts of shale, and sandstone fragments. This soil occupies the highest hills and rolling plateaus of the southern tier from Broome county to Chautauqua county. Crops grown are oats, grass, buckwheat, potatoes, rye and small amounts of corn and wheat. Good apple orchards are found on this soil. The sample of soil was taken from the farm of Mr. J. J. Preswick, about three miles southeast of Ithaca, N. Y. The field was a potato field that gave a yield of about 150 bushels per acre with no application of a fertilizer of any kind. The previous yields were potatoes 100 to 150 bushels; oats, 30 bushels; grass, a scant ton per acre and buckwheat, 12 to 15 bushels. This field had been cleared eighty years and no fertilizer, either stable manure or commercial, had ever been used.

No. 1896.— A brown or black loam, six to ten inches deep, resting on a heavy yellow, silty loam containing numerous shale fragments and having a depth of three feet or more, this, in turn, underlain by shale rock. This soil occurs typically developed on rolling uplands, but extends to lower levels along streams and lakes. It is derived from glacial material. It is found in Ashtabula county, Ohio, Chautauqua, Tompkins and Cayuga counties, New York, and intermediate localities at from 12 to 2,000 feet above sea level. In New York, it is the basis of the dairying and general farming industries. The sample was collected on the farm of Charles Norris, about three miles northeast of Ithaca. The field was corn stubble and was manured the previous year with twenty-five loads of stable manure. No commercial fertilizer had been used on the field in twenty years. The rotation was corn, oats and grass. The yields of corn were from 100 to 125 bushels of ears per acre; oats, 40

bushels; grass, 1½ to 2 tons per acre. The field had been cleared at least seventy-five years. The sample consisted of a brown loam, fairly well granulated and contained a considerable amount of large flat shale and a high percentage of small, flat shale chips.

No. 1898.— This soil was a yellow to brown clay loam, six to twelve inches deep, underlain by mottled joint clay to a depth of six feet or more, this, in turn, underlain by boulder clay or by rock, occasionally underlain by gravel. This is a glacial lake sediment deposited in quiet water and is associated with gravelly loams and sandy loams of similar origin. In some areas, this type of soil is badly drained. The crops produced on it are wheat, oats and grass. Corn and buckwheat are raised to less advantage. It is a typical Concord grape soil under favorable climatic conditions and with good drainage. It occurs along Lake Erie in Ashtabula county, Ohio, and in Chautauqua county, N. Y. It is widely distributed in small areas in northern central New York and around the " Finger Lakes." The sample was taken from a corn field on the Cornell University farm about 300 yards south of the new filtration plant. On this type of soil, Professor Roberts secured his wheat yields of forty bushels per acre and over, the hay yields being from three to four per tons acre in 1904.

No. 1897.— The soil on the Station farm is a rather heavy clay loam and probably is quite similar to the soils classed as Dunkirk clay. The sample used was taken from the upper eight inches of a garden that had been used for a number of years for the production of small fruits, particularly strawberries.

No. 1900.— The sample of soil used was taken from the farm of J. V. Salisbury & Son, near Phelps, N. Y. This farm falls within the Onondaga limestone region.

No. 1901.— The soil used from this region was taken on the farm of F. A. Sirrine, near Riverhead, N. Y. It should be classed as a sandy loam, although it is not possible to state from existing information what class of sandy loams it falls into according to the classification of the Bureau of Soils.

No. 1902.— The town of Walton is situated in Delaware county, a region that is classified as to its geological characteristics as Catskill sandstone. The sample used was taken from the farm of Nathan Jenkins which is located in Walton.

CROP PRODUCTION ON THE UNFERTILIZED SOILS.

As previously stated, the purpose of this investigation is to compare the actual productiveness of the soils in question with the results obtained through chemical methods. In order to secure this comparison, a crop of barley was grown in the forcing house on the unfertilized soils during each of two seasons, the same lot of soils being used both seasons, that is, the crop for the second season was grown on the same soil as was used for the first season. Wooden boxes were used, 15 inches square, inside measurement. The soil was prepared as indicated on page 394: 40 pounds of soil were weighed into each box, 8 pounds of coarse sand and 4 pounds of fine sand being used in the bottom of each box for drainage. The boxes were watered with distilled water. It has been stated by the Bureau of Soils of the United States Department of Agriculture, that distilled water is toxic to plants. No such effect was observed in this instance. This water was distilled from the city supply, the source of which is mostly Seneca Lake. The crop grown was barley, which was allowed to develop to maturity. Duplicate boxes without fertilization were used with each soil and the results show a very satisfactory agreement of production. The production of dry matter for each of the two years and the total amount for the two years for each of the nine soils are given in Table I.

TABLE I.— PRODUCTION OF DRY SUBSTANCE PER BOX IN BARLEY ON THE UNFERTILIZED SOILS.

No.	First Year.			Second Year.			Total.
	Grain.*	Straw.*	Total dry substance.	Dry matter Grain.	Dry matter Straw.	Total dry substance.	Production in two years.
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
1894	16.5	27.	39.8	25.5	51.9	77.4	117.2
1895	23.7	32.5	51.2	17.3	35.3	52.6	103.8
1896	13.5	19.5	30.6	18.6	36.8	55.4	86.
1897	18.5	30.	44.4	20.9	45.1	66.	110.4
1898	40.	58.	90.3	26.9	44.3	71.2	161.5
1899	8.5	11.	17.9	22.5	56.4	78.9	96.8
1900	4.5	7.7	11.2	10.2	27.2	37.4	48.6
1901	4.5	8.	11.6	......	*2.5	*2.5	14.1
1902	1.	4.2	4.9	......	*4.5	*4.5	9.4

* Air dry.

It is to be noted that the growth of barley on the unfertilized soils with part of the soils is quite different the second year from what it was the first. This is markedly the case with soil No. 1899 and to a lesser degree with several others. Certain broad differences were maintained, however, as is seen in the relatively low production both years of soils Nos. 1900, 1901, 1902. The variation of the results of the second year from those of the first is explained most naturally through changes brought about in the soils by producing one crop on them and then holding them during an entire summer in a fallow condition. It would seem most rational to use the entire production for the two years as a basis of comparison with the analytical results to be given in what follows.

CHEMICAL INVESTIGATIONS.

The chemical studies of these soils were the following:

1. A complete analysis of the soils.
2. A determination of the materials soluble in hydrochloric acid sp. gr. 1.115 by the A. O. A. C. method.
3. A determination of the materials rendered soluble by continuous leaching for ten days with various solvents, water, N/200 HCl and N/25 HCl.
4. A determination of the soluble material obtained by shaking for five hours with various solvents, water, N/200 HCl, and N/25 HCl.

PREPARATION OF SOIL.

In order to secure the samples as well as to prepare the soils for experiments in the forcing house, each soil was sifted first through a one-half inch mesh sieve and finally through a sieve of one-fourth inch mesh. In this way, stones, turf, sticks and other coarse and foreign materials were removed. The whole mass of soil was then shoveled over many times until it was entirely homogeneous. Samples were then taken for analysis.

COMPLETE ANALYSIS OF THE SOILS.

By the method adopted, the entire amount of each ingredient present in the soil was determined and the results are shown in Table II.

TABLE II.— COMPLETE ANALYSIS OF THE SOILS.

Soil No.	SiO_2.	CaO.	MgO.	K_2O.	N_2O	Fe_2O_3	Al_2O_3.	P_2O_5.	SO_3.	CO_2.	N.	Loss in water and organic matter.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
1894	75.05	3.47	.39	1.11	.57	4.65	6.27	.22	.106	.35	.242	7.31
1895	75.47	3.02	.59	1.11	.56	4.84	7.68	.20	.082	.25	.160	6.13
1896	76.20	2.98	.62	1.08	.76	4.07	7.96	.20	.075	.21	.168	5.84
1897	74.01	3.80	.57	1.95	.92	3.49	8.56	.22	.088	.10	.173	5.85
1898	74.80	.68	.45	.80	1.21	3.49	11.22	.24	.102	.12	.181	6.41
1899	64.48	2.07	1.00	.72	2.28	4.07	14.09	.24	.093	.13	.182	6.26
1900	74.70	1.47	.96	1.07	.96	3.88	12.17	.15	.064	.28	.086	3.71
1901	90.40	.63	.75	.27	.69	1.94	2.41	.12	.040	.15	.063	2.27
1902	70.04	.64	.76	.79	.84	5.22	12.53	.22	.096	.25	.185	8.32

COMMENTS ON THE COMPOSITION OF THE SEVERAL SOILS AND ITS RELATION TO FERTILITY.

The complete analysis of the several soils shows marked differences in composition. The most prominent of these differences are the high silicic-acid content No. 1901, and the low percentage of this compound in No. 1899. The difference in the other soils in this respect is not marked. Samples Nos. 1898, 1901 and 1902 showed a very low percentage of calcium oxide and Nos. 1901 and 1902 a low percentage of nearly all the bases. The percentage of sulphur is especially low in Nos. 1900 and 1901. Nos. 1898, 1899, 1901 and 1902 apparently have a high percentage of aluminum silicate. When we consider the three elements that are given commercial value in fertilizers — nitrogen, phosphorus and potassium — we find marked differences, the lowest percentages of all of these elements being found in No. 1901, Nos. 1898, 1899, 1901 and 1902 ranking below the others in potassium and No. 1900 showing a relative deficiency in phosphorus. The soils comparatively low in nitrogen are Nos. 1900 and 1901.

Table III shows the results of a complete analysis of the nine soils under investigation, and also the production of barley obtained from these soils during two seasons, the last column giving the total production for two years. At first glance, it might

seem that the largest production is obtained from these soils that have the largest percentages of certain ingredients. Close examination, however, reveals such exceptions to this generalization as to render it untenable. The largest production for the two years was with No. 1898 and it is noteworthy that percentages of the oxides of calcium, magnesium, potassium, phosphorus and nitrogen are essentially the same in this soil as in No. 1902, which gave the lowest production, practically one-eighteenth as much as No. 1898. Possibly, it should be regarded as significant that Nos. 1900 and 1901 contained relatively small percentages of phosphorus and potassium. It cannot be said, however, that, in the case of these nine soils, a complete analysis gives a basis for judgment as to relative fertility, or as to the fertilizers that should be applied to strengthen the crop-producing capacity.

TABLE III.— COMPARISON OF SOIL COMPOSITION AND PRODUCTION OF BARLEY DRY SUBSTANCE.

No.	CaO.	MgO.	K_2O.	P_2O_5.	N.	CO_2.	Production Dry Substance.		
							First year.	Second year.	Total two years.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Grams.*	*Grams.*	*Grams.*
1894	3.47	.39	1.11	.22	.242	.35	39.8	77.4	117.2
1895	3.02	.59	1.11	.20	.160	.25	51.2	52.6	103.8
1896	2.98	.62	1.08	.20	.168	.21	30.6	55.4	86.
1897	3.80	.57	1.75	.22	.173	.10	44.4	66.	110.4
1898	.68	.45	.80	.24	.181	.12	90.3	71.2	161.5
1899	2.07	1.00	.72	.24	.182	.13	17.9	78.9	96.8
1900	1.47	.96	1.07	.15	.086	.28	11.2	37.4	48.6
1901	.63	.75	.27	.12	.063	.15	11.6	2.5	14.1
1902	.64	.76	.79	.22	.185	.25	4.9	4.5	9.4

DETERMINATIONS OF SOIL COMPOSITION BY THE A. O. A. C. METHOD, USING HCL SPECIFIC GRAVITY 1.115.

This method consists in the determination of the soil ingredients soluble in hydrochloric acid, specific gravity 1.115, when the soil is digested with the acid continuously for ten hours at a temperature of boiling water. The determinations of the various substances in this solution were made in accordance with approved methods. The results are given in Table IV.

TABLE IV.— SOIL INGREDIENTS SOLUBLE IN HCL SP. GR. 1.115.

LAB. No.	Insoluble residue.	CaO.	MgO.	K_2O.	Na_2O.	Fe_2O_3.	Al_2O_3.	P_2O_5.	SO_3.	Water and organic matter.	N.*
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*					
1894	85.30	.25	.32	.062	.030	2.87	2.90	.227	.106	7.31	.242
1895	86.02	.23	.42	.107	.031	2.99	3.32	.192	.082	6.13	.160
1896	86.87	.18	.39	.080	.024	2.99	3.13	.192	.075	5.84	.168
1897	86.57	.43	.27	.182	.053	2.79	3.08	.184	.088	5.85	.173
1898	84.33	.27	.43	.121	.021	3.22	4.50	.144	.102	6.41	.181
1899	83.89	.23	.60	.149	.053	3.49	4.61	.165	.093	6.26	.182
1900	88.37	.28	.37	.221	.047	2.83	3.87	.114	.064	3.71	.086
1901	95.39	.10	.07	.026	.020	.99	.96	.096	.040	2.27	.063
1902	80.38	.09	.32	.081	.043	4.93	4.91	.184	.096	8.32	.185

TABLE V.—COMPARISON OF SOIL INGREDIENTS SOLUBLE IN HCL 1.115 SP. GR. WITH PRODUCTION OF BARLEY DRY SUBSTANCE.

No.	CaO.	MgO.	K_2O.	P_2O_5.	N*.	Production Dry Substance. First year.	Production Dry Substance. Second year.	Production Dry Substance. Total two years.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Grams.*	*Grams.*	
1894	.25	.32	.062	.227	.242	39.8	77.4	117.2
1895	.23	.42	.107	.192	.160	51.2	52.6	103.8
1896	.18	.39	.080	.192	.168	30.6	55.4	86.
1897	.43	.27	.182	.184	.173	44.4	66.	110.4
1898	.27	.43	.121	.144	.181	90.3	71.2	161.5
1899	.23	.60	.149	.165	.182	17.9	78.9	96.8
1900	.28	.37	.221	.114	.086	11.2	37.4	48.6
1901	.10	.07	.026	.096	.063	11.6	2.5	14.1
1902	.09	.32	.081	.184	.185	4.9	4.5	9.4

* The percentages of nitrogen given in Tables IV and V represent the total present.

COMMENTS ON RESULTS WITH A. O. A. C. METHOD.

This insoluble residue left after treating the soils with HCl specific gravity 1.115 according to the A. O. A. C. method is not greatly unlike in the several samples with the exception that it is very large in No. 1901 and considerably below the average in No. 1902. The substances that are commercially most important in plant nutrition were dissolved in much the smallest proportions from No. 1901. A relatively small proportion of potassium was also extracted by this method from Nos. 1894 and 1901, the percentages of phosphorus taken out being quite uniform excepting the low

percentage from No. 1901 and the high percentage from No. 1894. The percentages of the soil ingredients dissolved by the hydrochloric acid of the strength specified are much more uniform than are the total percentages of these ingredients in the soils. Measurements of soil fertility by the two forms of analysis would result in quite unlike conclusions.

If No. 1901 were considered merely in comparison with certain others, it would seem that a relatively low percentage of calcium, magnesium, potassium, phosphorus and nitrogen extracted by this method is indicative of a corresponding low state of fertility. When, however, we compare No. 1896 with No. 1902 and note the similarity of results by this form of analysis and at the same time observe the wide variation in productiveness, we are led to conclude that this method of analysis does not give accurate measurements of fertility. No. 1898 appears to have little advantage as to composition over No. 1895, but is clearly superior in productiveness as is shown by two years' crops.

MATERIALS RENDERED SOLUBLE BY CONTINUOUS PERCOLATION OF SOILS FOR TEN DAYS WITH VARIOUS SOLVENTS.

Results of percolation for ten days with distilled water.— It is well known that a very large proportion of the constituents of the soil are in a highly insoluble form. It is also true that plants can feed only on compounds that are in some way brought into solution. It is obvious, therefore, that the extent and rate of solution in any given soil have an important bearing on the capacity of the soil to nourish plant life. This is true whether the solutions are of the ordinary physical character or are caused by what may be called the reactions of the plant roots. Heretofore, attempts have been made to measure soil fertility by brief treatment with water, namely, by shaking a quantity of soil in a given volume of water for three minutes and after standing twenty minutes, drawing off the supernatant liquid and determining the amount of the various substances that have entered into solution. Work done by the Bureau of Soils indicated that soluble materials obtained in this way bore no consistent relation to fertility. It appears that the concentration of soluble materials in soil moisture is, in general, quite alike for all soils. The capacity of a soil to rapidly and continuously renew the soluble material contained in the soil moisture does not seem to have been considered and on theoretical grounds this would appear to be an important factor. It was for the purpose of studying this particular point that the several soils under experimentation

were submitted to continuous leaching for ten days. The method followed was to percolate continuously 500 grams of air-dried soil, the percolation being so regulated that 500 c. c. of filtrate was delivered each twenty-four hours. Determinations of the soluble materials in each day's filtrate were made. The results may be seen in Table VI.

TABLE VI.— CONTINUOUS PERCOLATION OF SOILS WITH WATER FOR 10 DAYS.
(Parts soluble in 1,000,000 of soil.)

No. 1894.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.	No. 1895.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.
1st 24 hrs...	852	208	12.4	1.	1st 24 hrs..	664	190	11.2	1.1
2d " " ...	162	76	5.	1.1	2d " " ..	156	58	5.4	1.5
3d " " ...	162	52	7.	.38	3d " " ..	122	60	5.	1.0
4th " " ...	118	40	5.	1.6	4th " " ..	100	56	2.4	1.4
5th " " ...	124	44	4.6	1.2	5th " " ..	84	46	3.4	.9
6th " " ...	134	48	6.6	.64.	6th " " ..	70	32	5.	.26
7th " " ...	154	58	3.	1.1	7th " " ..	76	36	1.7	1.
8th " " ...	110	42	1.3.	1.9	8th " " ..	70	32	.5	2.4
9th " " ...	99	36	1.	1.1	9th " " ..	56	28	.26	.9
10th " " ...	80	30	.76	2.4	10th " " ..	56	26	1.4	2.6
Total....	1995	634	46.66	12.42	Total....	1454	564	36.26	13.06
11th 24 hrs...	86	28	1.	.64	11th 24 hrs..	48	20	1.1	1.8
12th " " ...	72	22	2.6	1.	12th " " ..	42	18	.78	.26
13th " " ...	72	24	4.2	.64	13th " " ..	44	22	7.	.9
14th " " ...	72	24	.64	1.4	14th " " ..	42	20	.38	1.
15th " " ...	56	15	.00	.9	15th " " ..	38	15	.00	.26
16th " " ...	52	16	1.	.9	16th " " ..	34	16	4.	1.0

No. 1896.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.	No. 1897.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.
1st 24 hrs...	620	160	12.8	1.2	1st 24 hrs..	906	372	24.	2.8
2d " " ...	162	52	7.	.38	2d " " ..	230	100	13.2	1.9
3d " " ...	112	46	5.	1.26	3d " " ..	174	80	10.8	3.
4th " " ...	86	38	1.4	1.8	4th " " ..	164	80	10.8	3.4
5th " " ...	68	30	4.6	.76	5th " " ..	134	60	8.8	2.6
6th " " ...	66	28	4.2	2.	6th " " ..	110	54	11.2	2.6
7th " " ...	70	32	2.2	1.2	7th " " ..	94	46	6.6	2.2
8th " " ...	60	28	.8	1.6	8th " " ..	82	40	4.2	1.4
9th " " ...	56	24	.62	1.6	9th " " ..	80	40	7.4	2.4
10th " " ...	56	22	1.	1.8	10th " " ..	106	58	8.4	1.5
Total....	1356	460	39.62	13.60	Total...	2080	930	105.4	23.8
11th 24 hrs...	52	18	2.2	2.0					
12th " " ...	45	18	1.2	.64					
13th " " ...	42	18	4.2	.6					
14th " " ...	45	18	2.	1.4					
15th " " ...	45	16	.10	.76					
16th " " ...	38	14	4.6	1.1					

TABLE VI (*continued*).

No. 1898.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.	No. 1899.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.
1st 24 hrs...	1356	272	5.8	.78	1st 24 hrs..	736	140	6.6	1.0
2d " " ...	206	88	5.4	.52	2d " " ..	106	38	3.8	.9
3d " " ...	170	80	1.7	1.6	3d " " ..	76	26	3.2	1.7
4th " " ...	122	46	3.4	2.6	4th " " ..	60	20	3.2	3.
5th " " ...	112	38	3.6	1.1	5th " " ..	56	20	1.1	.76
6th " " ...	112	46	3.8	1.8	6th " " ..	38	18	1.5	1.5
7th " " ...	92	44	2.4	2.	7th " " ..	42	18	3.	.76
8th " " ...	114	72	.5	1.0	8th " " ..	42	15	1.08	.38
9th " " ...	56	34	2.2	2.2	9th " " ..	36	12	.92	.90
10th " " ...	42	24	1.6	1.5	10th " " ..	56	14	3.4	.64
Total....	2382	744	30.4	15.10	Total....	1248	321	31.20	11.54

No. 1900.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.	No. 1901.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.
1st 24 hrs...	1382	958	7.8	.76	1st 24 hrs..	270	86	14.8	1.1
2d " " ...	208	108	8.8	.90	2d " " ..	90	30	13.2	2.2
3d " " ...	138	72	2.4	1.7	3d " " ..	54	20	4.2	2.0
4th " " ...	98	54	1.9	2.6	4th " " ..	50	22	10.4	3.
5th " " ...	80	36	1.8	1.0	5th " " ..	32	12	2.6	.64
6th " " ...	102	64	1.1	.52	6th " " ..	28	16	2.6	1.9
7th " " ...	88	56	1.8	1.1	7th " " ..	30	14	.70	1.7
8th " " ...	70	38	.15	.38	8th " " ..	26	11	.00	.90
9th " " ...	64	26	1.5	1.2	9th " " ..	22	10	.38	1.5
10th " " ...	58	30	1.7	.64	10th " " ..	32	11	2.6	.90
Total....	2288	1442	28.95	10.80	Total...	634	232	51.48	15.84

No. 1902.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.	No. 1902.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.
1st 24 hrs....	394	74	4.6	.64	6th 24 hrs..	72	26	1.8	1.2
2d " "	160	36	1.5	.9	7th " " ..	68	22	1.4	.26
3d " "	110	30	1.3	1.2	8th " " ..	64	20	1.0	1.2
4th " "	100	28	1.5	2.4	9th " " ..	54	17	1.5	.52
5th " "	82	22	.96	1.	10th " " ..	54	16	1.	1.
Total....	846	190	9.86	6.14	Total...	312	101	5.17	4.18

COMMENTS ON THE RESULT OF PERCOLATING THE SEVERAL SOILS WITH WATER.

The several soils show very unlike proportions of solubles by this method. For instance, there was dissolved by the first day's treatment from the No. 1898, 1356 parts of dry matter per million

of soil, and during the ten days' continuous percolation, 2382 parts, while No. 1901 yielded from the first day's percolation only 270 parts per million of soil and from ten days' treatment, only 634 parts. These general differences apply both to the organic and inorganic substance dissolved. In general, larger proportions of potassium compounds were dissolved during the first day than on any subsequent day. With a majority of the soils, there was a somewhat regular diminution of solution of potassium compounds during the ten days' treatment. With the phosphorus compounds, no excess of solution was observed for the first day and the amount given up per day was quite uniform throughout the ten days and with all the soils. As has been previously observed, percolation with water dissolves much smaller amounts of phosphorus compounds from the soils than is true of the potassium compounds. The amounts of potassium compounds and phosphorus compounds dissolved by this treatment either during the first day, or during the entire ten days, bore no consistent relation to the proportion of these compounds in the soils.

TABLE VII.— SOLUBLES FROM 24 HOURS' CONTINUOUS LEACHING WITH WATER COMPARED WITH PRODUCTION OF BARLEY DRY SUBSTANCE.

No.	Parts in 1,000,000 of Soil.					Production Dry Substance.		
	Total.	Volatile and organic.	Inorganic.	K_2O.	P_2O_5.	First year.	Second year.	Total two years.
						Grams.	*Grams.*	*Grams.*
1894	852	644	208	12.4	1.0	39.8	77.4	117.2
1895	664	474	190	11.2	1.1	51.2	52.6	103.8
1896	620	460	160	12.8	1.2	30.6	55.4	86.
1897	906	534	372	24.	2.8	44.4	66.	110.4
1898	1,356	1,084	272	5.8	.78	90.3	71.2	161.5
1899	736	596	140	6.6	1.0	17.9	78.9	96.8
1900	1,382	424	958	7.8	.76	11.2	37.4	48.6
1901	270	184	86	14.8	1.10	11.6	2.5	14.1
1902	394	320	74	4.6	.64	4.9	4.5	9.4

It had been hoped that the measurements most indicative of relative fertility would be obtained by percolation with water and weak acids. The foregoing figures show the parts per million leached

from the several soils during twenty-four hours' continuous percolation with water. It can be seen at a glance that so far as the phosphoric acid and potash are concerned, the amounts brought into solution have no significance whatever as an indication of relative fertility. There does appear to be, however, some relation, though not very definite, between the amount of soluble matter leached from the soils, especially the organic portion, and the crop production. It is particularly true in the case of Nos. 1900, 1901, and 1902 that a low amount of soluble organic matter accompanies low productive capacity. In the case of the other soils, the gradations of solubility of organic matter and productiveness are to some extent consistent with each other. The same is more or less true of the inorganic soluble matter, but the relation is not as close.

TABLE VIII.—SOLUBLES FROM 10 DAYS' CONTINUOUS PERCOLATION WITH WATER COMPARED WITH PRODUCTION OF BARLEY DRY SUBSTANCE.

No	Parts in 1,000,000 of Soil.					Production Dry Substance.		
	Total.	Volatile and organic.	Inorganic.	K_2O.	P_2O_5.	First year.	Second year.	Total two years.
						Grams.	*Grams.*	*Grams.*
1894	1,995	1,361	634	46.7	12.4	39.8	77.4	117.2
1895	1,454	890	564	36.3	13.1	51.2	52.6	103.8
1896	1,356	896	460	39.6	13.6	30.6	55.4	86.
1897	2,080	1,150	930	105.4	23.8	44.4	66.	110.4
1898	2,382	1,638	744	30.4	15.1	90.3	71.2	161.5
1899	1,248	927	321	27.8	11.5	17.9	78.9	96.8
1900	2,288	846	1,442	28.9	10.8	11.2	37.4	48.6
1901	634	402	232	51.5	15.8	11.6	2.5	14.1
1902	1,158	867	291	16.5	10.3	4.9	4.5	9.4

The continuous percolation of soil with water for ten days gives results with the various soils relatively quite similar to those obtained by twenty-four hours' percolation. While there is a marked increase in the amount of organic matter dissolved, the increase in the inorganic matter is still greater. There is the same apparent relation between the amounts of organic matter brought into solution and the productiveness. As was shown with the twenty-four hour

percolation, there is no definite relation between the amounts of phosphoric acid and potash dissolved and the production of barley dry matter, although it is true, as was the case with the shorter time of percolation, soil No. 1902, which is the least productive, yields the smallest amounts of these two ingredients. On the other hand, No. 1901 which showed a very low rate of production, gave up to this extended percolation more phosphoric acid and potash than No. 1898 which shows the highest productiveness. It was hoped that in the capacity of these soils to renew rapidly the soil solutions would be found some measurement of relative productiveness, but this does not seem to be the case.

RESULTS OF PERCOLATION WITH N/200 HCL.

Many attempts have been made to stimulate the feeding action of the roots of plants by soils with a dilute acid of one kind or another. Investigations have been carried on with organic acids, such as citric. In this inquiry very dilute hydrochloric acid was used, the percolation being accomplished in the same general manner as with distilled water, namely, by treating 500 grams of soil with N/200 acid so that 500 grams of filtrate was discharged each twenty-four hours. The results of this treatment may be found in Table IX.

TABLE IX.— CONTINUOUS PERCOLATION OF SOILS WITH N/200 HCL FOR 10 DAYS.
(Parts in 1,000,000 of soil.)

No. 1894.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.	No. 1895.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.
1st 24 hrs...	1177	556	24.	.26	1st 24 hrs..	1018	502	16.	.26
2d " " ...	462	283	14.	.38	2d " " ..	456	288	10.	.38
3d " " ...	422	272	14.	.90	3d " " ..	430	258	9.6	1.40
4th " " ...	430	274	48.	1.20	4th " " ..	418	272	8.6	.90
5th " " ...	426	286	66.	.64	5th " " ..	438	314	10.	1.60
6th " " ...	412	252	14.	.64	6th " " ..	414	256	13.	.76
7th " " ...	416	236	11.	.38	7th " " ..	372	212	11.	.52
8th " " ...	410	232	12.	1.20	8th " " ..	366	194	11.	1.40
9th " " ...	390	214	11.	.64	9th " " ..	346	174	8.	.76
10th " " ...	356	200	12.	.52	10th " " ..	282	128	8.4	1.8
Total....	4,901	2,805	226.	6.76	Total...	4,540	2,598	105.6	9.78

TABLE IX (*continued*).

No. 1896.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.	No. 1897.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.
1st 24 hrs...	938	442	19.	.52	1st 24 hrs..	1,290	680	34.	.76
2d " " ...	454	302	54.	.52	2d " " ..	592	362	28.	1.40
3d " " ...	408	264	11.4	1.80	3d " " ..	476	324	28.	1.70
4th " " ...	402	270	66.	1.80	4th " " ..	496	326	22.	1.20
5th " " ...	362	234	94.	1.60	5th " " ..	486	328	60.	2.60
6th " " ...	382	198	10.	1.20	6th " " ..	646	304	18.	2.20
7th " " ...	380	174	42.	.76	7th " " ..	444	328	16.	.76
8th " " ...	374	150	7.4	.64	8th " " ..	446	296	14.4	1.50
9th " " ...	330	152	5.2	1.20	9th " " ..	468	334	12.	1.50
10th " " ...	270	128	6.2	2.20	10th " " ..	442	306	15.	1.40
Total....	4,300	2,314	315.2	12.24	Total...	5,786	3,588	247.4	15.02

No. 1898.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.	No. 1899.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.
1st 24 hrs...	1,647	670	20.	.52	1st 24 hrs..	906	404	9.6	.52
2d " " ...	566	316	13.	1.40	2d " " ..	466	266	10.	.60
3d " " ...	454	246	15.8	1.90	3d " " ..	438	246	10.	2.80
4th " " ...	490	293	14.	1.10	4th " " ..	424	260	5.6	.90
5th " " ...	444	282	12.8	1.90	5th " " ..	420	264	5.2	.64
6th " " ...	414	274	10.	1.20	6th " " ..	382	232	7.4	2.00
7th " " ...	406	268	11.	.64	7th " " ..	368	216	4.0	1.40
8th " " ...	412	280	11.2	1.50	8th " " ..	362	192	5.2	1.00
9th " " ...	406	264	8.8	1.20	9th " " ..	348	194	3.6	.76
10th " " ...	407	290	14.	1.60	10th " " ..	302	158	3.4	1.50
Total....	5,646	3,183	130.6	12.96	Total...	4,416	2,432	63.4	12.12

No. 1900.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.	No. 1901.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.
1st 24 hrs...	1,612	1,094	9.2	.52	1st 24 hrs..	652	308	28.	.52
2d " " ...	472	316	4.8	.90	2d " " ..	380	234	10.8	1.10
3d " " ...	456	261	5.6	1.10	3d " " ..	332	172	8.4	1.80
4th " " ...	538	270	4.8	.76	4th " " ..	330	154	12.8	2.60
5th " " ...	536	270	3.8	.76	5th " " ..	232	144	12.6	3.60
6th " " ...	468	279	6.0	.70	6th " " ..	344	132	6.2	4.00
7th " " ...	428	272	4.2	.50	7th " " ..	294	112	4.0	4.80
8th " " ...	412	274	4.0	1.00	8th " " ..	264	104	4.0	5.60
9th " " ...	426	286	4.6	.76	9th " " ..	232	100	2.6	5.60
10th " " ...	400	286	6.8	2.00	10th " " ..	198	112	6.2	5.40
Total....	5,750	3,608	53.8	9.00	Total...	3,258	1,572	95.6	35.02

TABLE IX (*concluded*).

No. 1902.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.	No. 1902.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.
1st 24 hrs....	762	352	11.	.38	6th 24 hrs..	396	124	2.0	1.00
2d " "	460	260	6.4	1.30	7th " " ..	348	124	1.2	1.40
3d " "	384	174	7.2	1.40	8th " " ..	340	114	3.6	3.20
4th " "	354	142	6.4	.76	9th " " ..	284	120	1.8	1.10
5th " "	232	134	4.8	.90	10th " " ..	238	120	4.4	2.20
Total....	2,192	1,062	36.8	4.74	Total...	1,606	602	13.0	8.90

TABLE X.— SOLUBLES FROM PERCOLATION WITH N/200 ACID FOR 24 HOURS; COMPARED WITH BARLEY DRY MATTER PRODUCED.

No.	Parts in 1,000,000 of Soil.					Production Dry Substance.		
	Total.	Volatile and organic.	Inorganic.	K_2O.	P_2O_5.	First year.	Second year.	Total two years.
1894...	1,177	611	566	24.	.26	39.8	77.4	117.2
1895...	1,018	516	502	16.	.26	51.2	52.6	103.8
1896...	938	496	442	19.	.52	30.6	55.4	86.
1897...	1,290	610	680	34.	.76	44.4	66.	110.4
1898...	1,647	977	670	20.	.52	90.3	71.2	161.5
1899...	906	502	404	9.6	.52	17.9	78.9	96.8
1900...	1,612	518	1,094	9.2	.52	11.2	37.4	48.6
1901...	652	344	308	28.	.52	11.6	2.5	14.1
1902...	762	410	352	11.	.38	4.9	4.5	9.4

TABLE XI.— SOLUBLES FROM PERCOLATION WITH N/200 HCL FOR 10 DAYS, COMPARED WITH PRODUCTION OF BARLEY DRY MATTER.

No.	Parts in 1,000,000 of Soil.					Production Dry Substance.		
	Total.	Volatile and organic.	Inorganic.	K_2O.	P_2O_5.	First year.	Second year.	Total two years.
1894...	4,901	2,096	2,805	226.	6.76	39.8	77.4	117.2
1895...	4,540	1,942	2,598	105.6	9.80	51.2	52.6	103.8
1896...	4,300	1,986	2,314	315.2	12.24	30.6	55.4	86.
1897...	5,786	2,198	3,588	247.4	15.02	44.4	66.	110.4
1898...	5,646	2,463	3,183	130.6	12.96	90.3	71.2	161.5
1899...	4,416	1,984	2,432	63.4	12.12	17.9	78.9	96.8
1900...	5,750	2,142	3,608	53.8	9.00	11.2	37.4	48.6
1901...	3,258	1,686	1,572	95.6	35.02	11.6	2.5	14.1
1902...	3,798	2,134	1,664	48.8	13.64	4.9	4.5	9.4

COMMENTS ON RESULTS FROM PERCOLATION WITH N/200 HCL.

Percolation for 24 hours.— As was the case with water percolation, the total amount of material dissolved by the weak acid during the first day was greatly in excess of the total solubles on any succeeding day. After the first day, however, the amount of dry matter brought into solution daily by the weak acid did not diminish as rapidly as was the case with the water percolation. Differences in the solubility of the various soils with the weak acid were as marked as with the water. To illustrate, No. 1898 gave up the first day with the acid 1,647 parts per million of soil and in the ten days, 5,646 parts, whereas No. 1901 soil gave up only 652 parts and during the ten days, only 3,258 parts. While the weak acid was much more effective in dissolving potassium compounds than was the water, it is a remarkable fact that the solubility of phosphorus compounds was less in many cases with the former solvent. As was the case with the water percolation, the proportions of phosphorus compounds dissolved were quite uniform throughout the ten days and the amount given up daily was fully as much during the last days of percolation as during the first. With the potassium compounds, on the contrary, the first day's solution, in general, exceeded that of any one of the last two or three days. The rate of solution did not drop after the first day as rapidly as with water, indeed in several instances larger amounts were dissolved with the weak acid after several days' percolation than on the first day.

It is interesting to compare a very weak acid with water as solvents in the study of soil fertility. As with water treatment, though in a less degree, there appears to be some relation between the amount of organic matter dissolved by the N/200 acid and productiveness. No relation is evident, however, between the amounts of phosphoric acid and potash brought into solution by the acid and the crop-producing power.

No. 1901 gave up to the acid more potassium and as much phosphorus as did No. 1898 although the crop of barley from the former was less than one-tenth as large as from the latter.

Percolation for 10 days.— The solubilities of the various soils through their continued percolation with N/200 acid for ten days vary less widely than is shown from percolation of the soils with the same acid during twenty-four hours. It can not be said that this long continued treatment gives results that indicate either

the relative value of the soils or the treatment necessary to increase fertility. It should be said, however, that the solubility of the inorganic matter in soil No. 1901 and soil No. .1902, which give very low yields, is very low as compared with the other soils. There is the same tendency to a low solubility of the potash and phosphoric acid, although in the case of No. 1901, the phosphoric acid stands in marked exception to this statement. This long continued treatment with the weak acid appears to be no more hopeful than the other methods as a means of measuring soil fertility.

RESULTS OF PERCOLATION FOR TEN DAYS WITH N/25 HCL ACID.

This percolation was carried on in the same manner as with the water and N/200 acid. The results are given in Table XII.

TABLE XII.— CONTINUOUS PERCOLATION OF SOILS WITH N/25 HCL FOR 10 DAYS. (Parts in 1,000,000 of soil.)

No. 1894.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.	No. 1895.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.
1st 24 hrs...	3,448	1,802	62.	1.50	1st 24 hrs..	3,364	1718	56.	2.80
2d " " ...	3,144	1,442	52.	4.00	2d " " ..	3,586	1054	44.	3.40
3d " " ...	3,164	1,102	52.	4.40	3d " " ..	4,334	964	22.	4.00
4th " " ...	2,552	910	34.	4.00	4th " " ..	2,046	668	24.	2.60
5th " " ...	3,588	776	13.	3.00	5th " " ..	2,882	672	7.2	2.40
6th " " ...	2,022	602	6.4	7.20	6th " " ..	1,038	418	4.4	3.80
7th " " ...	2,602	446	10.	1.20	7th " " ..	756	309	3.4	1.20
8th " " ...	1,026	400	2.	3.80	8th " " ..	806	389	2.0	2.80
9th " " ...	752	320	5.8	.64	9th " " ..	382	324	5.2	.38
10th " " ...	704	330	2.8	.24	10th " " ..	798	400	2.4	.38
Total....	22,882	8,130	240.	29.88	Total...	19,992	6,916	170.6	40.82

No. 1896.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.	No. 1897.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.
1st 24 hrs...	3,216	1,506	46.	1.40	1st 24 hrs..	3,906	2,061	84.	3.40
2d " " ...	3,050	1,016	36.	4.00	2d " " ..	3,566	2,038	72.	1.90
3d " " ...	3,358	1,060	36.	2.40	3d " " ..	3,444	1,694	70.	3.40
4th " " ...	1,886	648	22.	2.40	4th " " ..	2,800	1,576	68.	14.00
5th " " ...	2,488	630	8.	3.20	5th " " ..	3,210	1,510	60.	10.80
6th " " ...	1,150	436	4.4	4.00	6th " " ..	2,782	1,206	38.	26.00
7th " " ...	740	522	5.0	2.00	7th " " ..	2,126	983	40.	20.00
8th " " ...	886	424	2.2	2.40	8th " " ..	1,750	744	20.	13.
9th " " ...	692	304	4.4	.26	9th " " ..	1,370	602	16.	16.
10th " " ...	716	350	1.8	.38	10th " " ..	1,104	598	10.8	8.6
Total....	18,182	6,896	165.8	39.02	Total...	26,508	13,072	478.8	117.10

TABLE XII (*concluded*).

No. 1898.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.
1st 24 hrs...	4,272	2,066	74.	3.80
2d " " ...	3,136	1,764	78.	1.00
3d " " ...	2,918	1,446	86.	3.00
4th " " ...	2,600	958	52.	3.40
5th " " ...	4,006	960	24.	5.20
6th " " ...	2,126	720	12.	7.60
7th " " ...	1,026	482	11.	3.40
8th " " ...	906	420	2.8	3.
9th " " ...	994	418	7.	.90
10th " " ...	820	430	4.2	1.80
Total....	22,804	9,664	351.0	33.10

No. 1899.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.
1st 24 hrs..	3,080	1,580	46.	1.50
2d " " ..	2,782	1,174	30.	3.80
3d " " ..	4,036	1,032	30.	4.80
4th " " ..	1,950	722	19.	3.00
5th " " ..	3,444	848	10.	1.90
6th " " ..	1,874	690	6.4	6.20
7th " " ..	1,532	600	9.6	2.00
8th " " ..	1,280	558	4.0	1.60
9th " " ..	1,326	560	9.4	.78
10th " " ..	1,208	592	3.2	1.10
Total...	22,512	8,356	167.6	26.58

No. 1900.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.
1st 24 hrs...	4,788	2,454	22.	1.20
2d " " ...	3,274	1,630	19.	1.50
3d " " ...	3,468	1,194	20.	3.80
4th " " ...	1,926	736	22.	3.40
5th " " ...	2,722	762	9.4	3.00
6th " " ...	1,262	440	4.6	3.60
7th " " ...	756	339	6.8	.90
8th " " ...	738	372	2.2	1.70
9th " " ...	706	328	5.0	.90
10th " " ...	748	368	3.0	2.80
Total....	20,388	8,623	114.0	22.80

No. 1901.	Total dry matter.	Total inorganic substance.	K_2O.	P_2O_5.
1st 24 hrs..	2,468	780	38.	24.00
2d " " ..	1,628	464	17.	22.00
3d " " ..	1,064	342	8.6	16.00
4th " " ..	566	242	9.8	12.00
5th " " ..	728	270	3.4	9.60
6th " " ..	352	148	5.2	4.40
7th " " ..	226	112	5.4	3.00
8th " " ..	494	154	1.8	2.40
9th " " ..	242	120	3.4	.38
10th " " ..	272	142	1.8	2.60
Total...	8,040	2,774	94.4	96.38

No. 1902.	Total dry matter.	Total Inorganic substance.	K_2O.	P_2O_5.
1st 24 hrs...	2,554	926	30	3.40
2d " " ...	3,782	882	17.	2.80
3d " " ...	3,542	824	9.6	.64
4th " " ...	2,780	802	9.8	3.80
5th " " ...	4,196	824	5.6	4.20
6th " " ...	2,984	792	4.8	7.40

No. 1902.	Total dry matter.	Total Inorganic substance.	K_2O.	P_2O_5.
7th 24 hrs..	2,388	702	3.8	2.20
8th " " ..	2,354	704	.2	10 00
9th " " ..	1,930	576	6.0	7.60
10th " " ..	2,000	654	1.2	1.60
Total....	28,510	7,686	88.0	43.64

TABLE XIII.— SOLUBLES FROM PERCOLATION WITH N/25 ACID FOR 24 HOURS, COMPARED WITH PRODUCTION OF BARLEY DRY MATTER.

No.	Parts in 1,000,000 of Soil.					Production Dry Substance.		
	Total.	Volatile and organic.	In-organic.	K_2O.	P_2O_5.	First year.	Second year.	Total two years.
						Grams.	*Grams.*	
1894...	3,448	1,646	1,802	62	1.5	39.8	77.4	117.2
1895...	3,364	1,646	1,718	56	2.8	51.2	52.6	103.8
1896...	3,216	1,710	1,506	46	1.4	30.6	55.4	86.
1897...	3,906	1,845	2,061	84	3.4	44.4	66.	110.4
1898...	4,272	2,206	2,066	74	3.8	90.3	71.2	161.5
1899...	3,080	1,500	1,580	46	1.5	17.9	78.9	96.8
1900...	4,788	2,334	2,454	22	1.2	11.2	37.4	48.6
1901...	2,468	1,688	780	38	24.	11.6	2.5	14.1
1902...	2,554	1,628	926	30	3.4	4.9	4.5	9.4

TABLE XIV.— SOLUBLES FROM CONTINUOUS PERCOLATION FOR 10 DAYS WITH N/25 ACID, COMPARED WITH PRODUCTION OF BARLEY DRY MATTER.

No.	Parts in 1,000,000 of Soil.					Production Dry Substance.		
	Total.	Volatile and organic.	In-organic.	K_2O.	P_2O_5.	First year.	Second year.	Total two years.
						Grams.	*Grams.*	*Grams.*
1895...	22,882	14,752	8,130	240	29.9	39.8	77.4	117.2
1896...	19,992	13,076	6,916	170.6	40.8	51.2	52.6	103.8
1897...	18,182	11,286	6,896	165.8	39.0	30.6	55.4	86.
1898...	26,508	13,436	13,072	478.8	117.1	44.4	66.	110.4
1899...	22,804	13,140	9,664	351.	33.1	90.3	71.2	161.5
1900...	22,512	14,156	8,356	167.6	26.6	17.9	78.9	96.8
1901...	20,388	11,765	8,623	114.	22.8	11.2	37.4	48.6
1902...	8,040	5,266	2,774	94.4	96.4	11.6	2.5	14.1
1903...	28,510	20,824	7,686	88	43.6	4.9	4.5	9.4

Percolation with the stronger acid appears to obliterate the differences which are observed with the use of water and acid of the N/200 strength. It is a curious fact that with the stronger acid, the highest solubility is noted with the soil that showed a low

solubility with water and the weaker acid. Unlike the results with water and the weaker acid, the amount of dry matter brought into solution does not appear to diminish in any marked way during the first four or five days of percolation and, in some instances, the rate of solution increases. These results are not at all surprising, but they indicate that such treatment with an acid of the N/25 strength has little value in reaching a measurement of soil fertility whether for twenty-four hours or continuously for ten days.

MATERIALS DISSOLVED FROM SOILS WHEN SHAKEN FOR FIVE HOURS WITH VARIOUS SOLVENTS AT 40° C.

By this method, 93 grams of air-dried soil were shaken for five hours in 465 cubic centimeters of the solvent at a temperature of 40° C. The ratio of the soil to the solvent was as 1 to 5. In Tables XVI to XVII are given statements of the solubles in water, N/200 HCl and N/25 HCl.

TABLE XV.— SOLUBLES FROM SHAKING IN WATER 5 HOURS AT 40° C. COMPARED WITH PRODUCTION OF BARLEY DRY MATTER.

(Parts in 1,000,000 of soil.)

No.	Total.	Volatile and organic.	Inorganic.	K_2O.	P_2O_5.	Production Dry Substance.		
						First year.	Second year.	Total two years.
						Grams.	*Grams.*	*Grams.*
1894...	1,147	741	406	22.5	6.4	39.8	77.4	117.2
1895...	866	569	297	10.3	5.6	51.2	52.6	103.8
1896...	824	549	275	15.0	8.7	30.6	55.4	86.
1897...	1,300	725	575	60.0	5.6	44.4	66.	110.4
1898...	1,587	1,187	400	18.7	8.74	90.3	71.2	161.5
1899...	762	512	250	12.5	6.3	17.9	78.9	96.8
1900...	1,587	488	1,099	12.0	4.0	11.2	37.4	48.6
1901...	712	375	337	21.2	6.3	11.6	2.5	14.1
1902...	724	524	200	4.7	4.0	4.9	4.5	9.4

TABLE XVI.— SOLUBLES FROM SHAKING IN N/200 HCL FOR 5 HOURS AT 40° C. COMPARED WITH PRODUCTION OF BARLEY DRY MATTER.

(Parts in 1,000,000 of soil.)

No.	Total.	Volatile and organic.	In-organic.	K_2O.	P_2O_5.	Production Dry Substance. First year.	Second year.	Total two years.
						Grams.	*Grams.*	*Grams.*
1894...	3,625	1,988	1,637	79.9	10.3	39.8	77.4	117.2
1895...	2,387	850	1,537	75	4.0	51.2	52.6	103.8
1896...	2,325	863	1,462	65	6.3	30.6	55.4	86.
1897...	2,975	1,175	1,800	150	9.6	44.4	66.	110.4
1898...	3,264	1,439	1,825	96	7.8	90.3	71.2	161.5
1899...	2,450	1,063	1,387	59.9	4.0	17.9	78.9	96.8
1900...	3,287	1,175	2,112	31.2	4.7	11.2	37.4	48.6
1901...	2,025	738	1,287	59.9	4.0	11.6	2.5	14.1
1902...	2,187	1,213	974	46.2	8.7	4.9	4.5	9.4

TABLE XVII.— SOLUBLES FROM SHAKING IN N/25 HCL FOR 5 HOURS AT 40° C. COMPARED WITH PRODUCTION OF BARLEY DRY MATTER.

(Parts in 1,000,000 of soil.)

No.	Total.	Volatile and organic.	In-organic.	K_2O.	P_2O_5.	Production Dry Substance. First year.	Second year.	Total production in two years.
						Grams.	*Grams.*	*Grams.*
1894...	11,810	6,836	4,974	137.	23.7	39.8	77.4	117.4
1895...	9,823	5,474	4,349	70.	17.5	51.2	52.6	103.8
1896...	9,898	5,848	4,050	82.	16.	30.6	55.4	86.
1897...	15,750	6,226	9,524	250.	32.5	44.4	66.	110.4
1898...	12,250	5,563	6,687	158.	11.1	90.3	71.2	161.5
1899...	10,050	5,713	4,337	62.5	16.2	17.9	78.9	96.8
1900...	11,480	5,118	6,362	52.	23.	11.2	37.4	48.6
1901...	5,674	3,349	2,325	57.	68.	11.6	2.5	14.1
1902...	10,990	7,240	3,750	38.	21.	4.9	4.5	9.4

COMMENTS ON RESULTS OF SHAKING IN VARIOUS SOLVENTS FOR 5 HOURS.

The amount of dry matter brought into solution by the agitation of soil for five hours with water appears to have a general, though

not close, relation to the productiveness of the soils as shown by two seasons' cropping. This is true both of the organic and inorganic compounds. It cannot be said that any significance can be attached to the solubility of potassium and phosphorus bodies as shown by this method. Soil No. 1901 gave up of potassium and phosphorus bodies a larger proportion than was the case with other soils showing much larger productiveness. Only in the case of the No. 1902 is there any intimation that a lower solubility of potassium and phosphorus compounds has any relation to fertility. The use of the N/200 HCl as a medium in which to agitate the soil for five hours brings the solubilities to a closer uniformity and renders them more inconsistent, especially as to the potassium and phosphorus compounds, the relation of the results to productiveness. It is quite remarkable that in four instances less phosphorus was brought into solution with the weak acid than with water.

The use of the stronger acid N/25 HCl increases the soluble material to a marked degree. This is true not only of the total soluble matter, but of the potassium and phosphorus compounds. The solubilities shown for the several soils appear to have no definite relation to the composition of these soils as shown by a complete analysis, that is, mass gives no indication of the proportions of soluble material by the methods used.

In comparing the results by this method with the several solvents, there is justification in the conclusion that the treatment with water gives results more significant in their relation to the productiveness of the several soils than is the case with either of the acid solutions, but even with the water, if there is any significance in the results obtained, it is shown in the amounts of total soluble matter rather than in the proportions of potassium and phosphorus compounds brought into solution. Not much can be claimed, however, for a method that shows as high solubilities for a soil producing 14.1 grams of dry matter to the box as for a soil producing 96.8 grams of dry matter per box.

PLANT-FOODS FOR CROPS IN 1916.*

L. L. VAN SLYKE.

Farmers who depend to any extent upon commercial plant-foods in the growing of crops are confronted at the present time by a situation calling for careful consideration. Owing to the direct and indirect effects of the European War upon the sources of supply and the cost of the more important plant-food materials used in the manufacture of commercial fertilizers, conditions have arisen which are wholly without precedent in the history of the fertilizer industry of this country, and which were altogether beyond the power of anyone to foresee. In view of these profoundly disturbing conditions, a conference was recently held by representatives of the Agricultural Experiment Stations of the New England States, New Jersey and New York for the purpose of obtaining all possible information bearing on the situation, as a basis for furnishing advice to farmers in respect to the practical methods they can adopt during the season of 1916 to meet the unprecedented problems.

The statements embodied in this circular present the consensus of the members of the conference. The chief points discussed are the following:

1. Effects of the war upon the cost of plant-food materials.
2. Suggestions to farmers under present conditions.

I. EFFECTS OF THE WAR UPON THE COST OF PLANT-FOOD MATERIALS.

While it was expected that the European War would interfere more or less with the importation of certain plant-food materials, such as potash salts and basic slag phosphate, it was not anticipated that other forms would be affected much, if at all. But we have come recently to appreciate that practically every form of commercial plant-food has been more or less seriously influenced. It is a matter of interest to notice in more detail what is the present condition of our commercial plant-food supplies and in what way the conditions have developed.

1. POTASH COMPOUNDS.

Practically all of our agricultural potash has come from Germany and the importation has absolutely ceased. Most of the potash salts on hand in this country in 1914 was taken for the commercial fertilizers used in the season of 1915. So small are the supplies on

* A reprint of Circular No. 47, January 20, 1916.

hand that only a part of the commerical fertilizers to be offered for 1916 will contain any potash at all and these only one per ct. Muriate of potash, which normally retails for about $40 a ton, now commands a price of $600 and offerings are very small even at that figure.

2. PHOSPHORIC ACID MATERIALS.

Acid phosphate, which for many years has formed the main source of available phosphorus in commercial fertilizers, has gone up considerably in price. This is due chiefly to increase in the price of sulphuric acid from $5 to $25 a ton. Sulphuric acid is used in the manufacture of acid phosphate and also in making high explosives. Several hundred thousand tons of the sulphuric acid usually employed in making acid phosphate have been purchased at largely increased prices by manufacturers of explosives. Another smaller factor in the increased cost of acid phosphate is increase in freight rates of coastwise traffic, due directly to shipping demands of the war.

3. NITROGEN-CONTAINING MATERIALS.

Nitric acid is a necessary compound for the manufacture of high explosives. The nitric acid made in America has been obtained from nitrate of soda imported from Chili. The increased demand made by the large increase in the manufacture of high explosives has rapidly sent up the price of sodium nitrate. An added factor of embarrassment is due to the unexpected blocking of the Panama Canal, resulting in the delay of transportation of thousands of tons of nitrate on its way from Chili to the manufacturers of commercial fertilizers in the United States. Increased cost of ocean freight has further added to the cost of nitrate.

II. SUGGESTIONS TO FARMERS UNDER PRESENT CONDITIONS.

From the preceding statements, it can be appreciated, in some degree at least, what a profound disturbance has been created by the war in relation to the supply and cost of those plant-food materials upon which our farmers have more or less largely relied for help in feeding their crops. As would be anticipated, there has been a tendency for every other form of plant-food material to undergo a "sympathetic" increase in price, and we can not yet tell how far this increase all along the line may extend.

What can farmers do in supplying plant-foods to their crops during the season of 1916 under present conditions? Let us first summarize the facts of the situation: (1) Potash materials from Germany are not obtainable except at prohibitive prices and even then only in insignificant amounts. (2) Our chief source of phosphoric acid, acid phosphate, is selling at prices much above those paid under normal conditions. (3) Nitrate of soda is obtainable in less amounts than usual and only at a large advance in cost.

As an outline of what farmers can do to furnish crops the supplementary plant-food supplies needed, greater care than ever before must be given to —

1. The selection of soils for crops.
2. The management of soils so as to utilize to the fullest possible extent the plant-food supplies already in the soil.
3. The conservation and utilization of all sources of plant-foods produced on the farm.
4. The selection of such commercial plant-food materials as are most economical.
5. Careful study of the plant-food needs of different crops.
6. Precautions to be observed in purchasing fertilizers.

We will now consider these points in order in more detail.

1. SELECTION OF SOILS FOR CROPS.

It will be possible to economize in the use of fertilizers by a careful selection of soils for certain crops. In making such selection, one can be guided by the following considerations:

(*a*) For those crops which are to be converted directly into money, only the better soils should be used.

(*b*) Clay soils and clay loams meet the desired plant-food conditions better than light soils, especially since heavier soils contain more available potash.

(*c*) Soils which have been systematically supplied with farm manure or commercial fertilizers will meet conditions of temporary food shortage better than those which have not been so well treated.

(*d*) Soils containing abundance of organic matter can do well with a minimum added supply of nitrogen.

(*e*) Fields which have been in constant cultivation for long periods of time usually require greater addition of plant-foods, especially for hoed crops, than do fields of newly-turned sod, particularly clover sod.

(*f*) Only soils in a good state of cultivation, that is, in good mechanical condition, should be used for money crops.

2. MANAGEMENT TO UTILIZE PLANT-FOOD IN SOIL.

Insoluble plant-foods in agricultural soils can be made available during the crop-growing season in sufficient quantities to meet to a greater or less extent the demands of growing crops, and thus need of additional commercial plant-foods can be much reduced. Two general methods can be used, (a) tillage, (b) indirect fertilizers.

(*a*) *Tillage.*—There has never been a time when tillage will pay so well. The soil should be plowed deeper than usual and harrowed more thoroughly. In keeping the soil texture as nearly perfect as possible by tillage, conditions are furnished which enable the soil

to retain moisture to the extent most desirable and to make soluble insoluble plant-food materials in the soil while, at the same time, making it easier for the feeding rootlets to reach out into the soil to obtain nourishment.

(b) *Indirect fertilizers.*—An indirect fertilizer is a material which favorably influences plant growth, not by furnishing in itself any needed element of plant-food, but chiefly by producing in the soil some effect beneficial to plant growth. Among such beneficial effects, one of the chief is the conversion of insoluble into soluble plant-food; another is the conversion of acids and other compounds unfavorably affecting plant growth into harmless forms. The indirect fertilizers to which attention should be called at this time are the following: (1) calcium or lime compounds and (2) common salt.

(1) Calcium or lime compounds include (a) the carbonate (ground limestone, air-slaked lime, marl, etc.), (b) the oxide (quicklime, burnt lime, lump lime, etc.), (c) the hydroxide (hydrated or slaked lime, and (d) the sulphate (gypsum, land-plaster).

The chief effects of the first three calcium compounds are, first, to neutralize acids in soil; second, to hasten the decomposition of organic matter, thus making its plant-foods more quickly available; and, third, to lighten heavy soils and compact light ones.

It has been generally believed that lime compounds have the power to change insoluble potash compounds into soluble forms, but the latest investigations appear to indicate that while the sulphate (gypsum) may do so in some degree, the other calcium compounds that are commonly applied to soils do not have such power to any appreciable extent. The cost of gypsum is too high to use on soils, and, moreover, it must be remembered that, when we apply 100 pounds of acid phosphate, we are applying about 40 pounds of gypsum. Generally speaking, then, the application of calcium or lime compounds can not furnish potash to crops through action on the insoluble potash compounds of the soil, but they can make more quickly available the potash and other plant-foods in organic matter, such as cover-crops, muck, peat, vegetable wastes, etc.

When ground limestone is used on soils under conditions calling for prompt action, it should be finely ground; the more finely ground it is, the quicker will be its action.

(2) Common salt or sodium chloride.—The results of recent investigations indicate that sodium in this form can, to some extent, change insoluble potash compounds into soluble ones. While sodium cannot take the place of potassium in plant nutrition, it can make a certain amount of potash go farther in crop production. Agricultural salt can be obtained at the mine for about $2.50 a ton. It can be applied at the rate of 150 to 300 pounds an acre. Application to grass appears to give more marked results than with other crops. The sodium in sodium nitrate has the same power as an indirect fertilizer that the sodium or sodium chloride has.

3. CONSERVATION AND UTILIZATION OF FARM-PRODUCED PLANT-FOOD MATERIALS.

The present is a time, as never before, to save and utilize every form of plant-food material found on the farm.

(*a*) *Farm manure.*—In stables enough litter should be used to absorb completely the urine because, first, it contains a much higher percentage of nitrogen and potash than the solid excrement, and, second, these are in much more quickly available forms in urine than in solid excrement. Dry muck is one of the best absorbents for stable use. Any muck-bed on the farm should be utilized both in stables and also for direct application to soil. When manure is stored, it should be made into a compact heap with vertical sides and kept under cover if possible. The heap should be kept moist enough to prevent over-heating but not so wet that liquid drains from it.

Mixed farm manure made from well-fed animals and kept under proper conditions contains, per ton, 10 to 12 pounds of nitrogen, 5 to 7 pounds of phosphoric acid and 10 to 12 pounds of potash. One cord of manure varies in weight from 2 to 3 tons. A two-horse wagon load weighs about one ton.

(*b*) *Miscellaneous wastes.*—Materials usually allowed to go to waste should all be utilized. Leaves, stalks, trash, etc., can be given to pigs to work over into manure. Composting can be advantageously employed for vegetable and animal materials that cannot be made suitable in any other way for use as manure.

(*c*) *Ocean products.*—Seaweeds, marsh-grasses, etc., can be advantageously utilized for fertilizing purposes on farms near the seashore. Dried ground starfish is worth using where obtainable in amount.

(*d*) *Ashes.*—Wood-ashes should be saved and carefully stored in a dry place until applied to the soil. The potash in wood-ashes gives them an unusually high value at the present time.

4. COMMERCIAL PLANT-FOOD SUPPLIES.

What commercial fertilizers and materials can best be used under the present conditions to feed crops? We will state facts so far as they are obtainable at present.

(*a*) *Mixed commercial fertilizers.*—Two general classes of mixed fertilizers will be offered for 1916 according to present information, one containing only nitrogen and phosphoric acid and the other potash in addition to the extent of 1 per ct. The price charged for the potash will be about 25 cents a pound. Speaking generally, we cannot advise the purchase of commercial fertilizers containing potash under these conditions. In the amount of such a fertilizer as usually applied, the quantity of potash present is so small as to have little, if any, influence on plant growth. Investment in potash

at 25 cents a pound under the conditions can not be regarded as a paying one.

(*b*) *Nitrogen.*—For a single application to crops with the longer growing season, a mixture of different materials containing nitrogen will be found most effective. For example, a useful mixture is about one-third nitrate of soda, one-third sulphate of ammonia or cyanamid and one-third organic nitrogen (tankage, dried blood, etc.).

(1) Cyanamid.—Of the different commercial materials containing nitrogen, adapted to the use of crops, calcium cyanamid is at present cheapest. It has an availability about equal to that of sulphate of ammonia. When used alone in large amounts, it should not be allowed to come into contact with seeds or rootlets, and it is well, therefore, to apply it one or two weeks before seeding. On account of the calcium oxide (quicklime) contained in it, it must not be mixed with ammonium sulphate. When mixed with acid phosphate, not more than 200 pounds of cyanamid per ton of mixture should be used, owing to danger of reversion of the soluble phosphate. While cyanamid is usually disagreeable to handle on account of the irritating effect of the dust on the eyes and skin, it is not poisonous.

(2) Nitrate of soda can be used to advantage in the early stages of growth, especially for crops starting in cold weather and for all crops in colder regions. Nitrate acts more quickly than any other form of nitrogen. The value of the sodium in sodium nitrate as an indirect fertilizer, already referred to (p. 4), should be kept in mind in connection with the potash supply in the soil.

(3) Organic nitrogen.—The different organic materials containing nitrogen vary greatly in their availability as plant-food. The nitrogen in fine bone, tankage, fish, blood, cottonseed-meal and castor-pomace is approximately of the same availability. Nitrogen in tankage is at present cheaper than in other forms.

The different forms of wool and felt waste are rich in nitrogen but they are usually of slow action when applied directly to soils without previous treatment of some kind. When these materials can be obtained at low cost they can be worked over by pigs or carefully composted and applied to crops having a long growing season.

Muck and peat contain considerable nitrogen, which is, however, only slowly available. Their most effective use is as an absorbent in connection with stable manure.

(c) Phosphoric acid.—Quickly available phosphoric acid influences favorably the development of the root systems of plants. Its application is, therefore, of special value in connection with crops needing to make early growth, resulting in a longer growing season and enabling them to utilize more fully plant-food in the soil.

(1) Acid phosphate is the commercial form of phosphorus which acts most quickly in plant growth. Its present price is unusually

high, but it will be found desirable to use some in most cases, especially with the chief money crops.

(2) Bone and bone-tankage are somewhat slow to act as a source of available phosphorus, but they can be advantageously used as a part of a mixture in case of crops having a long growing season.

(3) Basic slag phosphate.—The European product is not obtainable. There is a good product made in the South, but the price is too high.

(4) Ground phosphate rock or "Floats" can not be recommended for general use where quick returns are essential. It is the least readily available of all the forms of commercial phosphates. When mixed with farm manure, it has given increased crop yields in some cases. Favorable results have also been obtained in connection with green manures and also in case of strongly acid muck soils with crops like onions and potatoes.

(d) Potash.—The situation is more serious in respect to commercial supplies of potash than of any other plant-food element.

(1) German potash salts (muriate, sulphate, kainit, etc.) are, as previously stated, practically unobtainable; the small supply on hand is held at prohibitive prices so far as agriculture is concerned.

(2) Ashes.—We are brought back to what was our original commercial source of potash for agriculture, viz, ashes. Wood-ashes limekiln-ashes, brickkiln-ashes, etc., contain some potash but the amount is very variable and can generally be depended upon to be small. Good hardwood-ashes should contain at least 5 per ct. of potash. It is significant that dealers at present *seldom guarantee more than 2 per ct. of potash*, and charge $15 to $25 a ton. Ashes should be purchased only under a guarantee of the percentage of potash.

(3) Ground-rock materials.—Advantage is being taken of the potash situation to push the sale of ground rocks containing unavailable potash. Ground feldspar is one of these materials. Such materials should not be purchased under any circumstances. They are extremely costly at any price, because the potash possesses no appreciable value as plant-food.

The chief dependence for 1916 must be the potash normally in the soil, largely in insoluble condition. We have already (p. 4) indicated how this supply may be made a source of available potash to crops during the growing season. It is probable that on most soils of this State the failure to apply the usual amount of potash salts will have little effect on crop production for 1916, especially if advantage is taken of the suggestions given.

5. SUGGESTIONS FOR DIFFERENT CROPS.

A few specific suggestions as to what fertilizers to use for some of our most common crops will not be out of place in concluding this circular.

(*a*) *Grass.*—For top-dressing ordinary grasslands, 100 to 200 pounds per acre of sulphate of ammonia may be used or the same amount of nitrate of soda or of cyanamid or of a mixture of the two can be used, or a mixed fertilizer high in nitrogen.

For clover and alfalfa an application is recommended of 500 to 1,000 pounds per acre of ashes if obtainable.

(*b*) *Corn.*—Use 10 to 12 tons of farm manure and on poorer soils supplement with 300 to 500 pounds of a fertilizer containing about 2.5 per ct. of nitrogen and 10 per ct. of available phosphoric acid.

(*c*) *Potatoes, root-crops and vegetables in general.*—Apply 4 tons of good farm manure and work it well into the soil. Supplement with 500 pounds of a fertilizer containing 2.5 to 3 per ct. of nitrogen and 8 to 10 per ct. of available phosphoric acid. If no manure is used, apply 800 to 1,000 pounds of fertilizer containing 4 per ct. of nitrogen and 8 to 10 per ct. of available phosphoric acid.

(*d*) *Cereals and spring-seeding to grass.*—For spring-seeding with cereals or grass in usual rotations, use per acre 300 to 500 pounds of a fertilizer containing 4 to 5 per ct. of nitrogen and 8 to 10 per ct. of available phosphoric acid.

(*e*) *Orchards.*—In place of applying fertilizer, use thorough tillage and grow cover-crops.

6. PRECAUTIONS IN THE PURCHASE OF FERTILIZERS.

(a) Obtain formulas and quotations from several manufacturers or dealers.

(b) Pay cash, if possible.

(c) Where practicable, combine with others to buy in mixed car lots.

(d) Insist on a guarantee with a rebate at current retail prices for any deficiency in composition.

(e) Look out for fake fertilizers rich in insoluble potash, phosphoric acid, etc.

(f) In case of doubt at any time, write to this Experiment Station.

CHEMICAL CHANGES IN THE SOURING OF MILK.*

LUCIUS L. VAN SLYKE AND ALFRED W. BOSWORTH.

SUMMARY

1. Fresh milk was analyzed for its soluble and insoluble constituents, using a porous porcelain filter for separation. Another portion of the same milk was inoculated with a culture containing ***Bacterium lactis acidi*** and ***B. lactis aerogenes***. At the end of 60 hours determinations were made of the soluble and insoluble portions. (a) About 22 per ct. of the milk-sugar is changed by the lactic acid bacteria, 88.5 per ct. of the amount so changed being converted into lactic acid. (b) Citric acid completely disappears. (c) The insoluble inorganic constituents of the fresh milk are made soluble by the lactic acid. (d) Albumin of sour milk passes through the porcelain filter completely. (e) Calcium caseinate is changed into free protein and precipitated, the calcium forming lactate.

2. To study the rate and extent of chemical change under given conditions, fresh, pasteurized, separator skim milk was inoculated with a pure culture of ***B. lactis acidi*** and kept at 32.2° C. Samples were taken at intervals during 96 hours for analysis. (a) Most of the change in milk-sugar occurs between the 10th and 24th hours. When the amount of lactic acid reaches 0.7 per ct., the bacterial activity is much reduced. (b) The acidity increases most rapidly during the first 24 hours, the rate of increase diminishing after that. The increased acidity of the serum is due to increase of lactic acid. In the insoluble portion of the milk the free casein is the acid constituent. (c) Calcium combined as $Ca\,H\,PO_4$ goes into solution completely in 13½ hours. Calcium combined as caseinate is acted upon more slowly, complete solution requiring about 24 hours. (d) The amount of albumin nitrogen in serum increases with increase of acidity; all the albumin of the milk appears in the serum in 14 hours.

INTRODUCTION.

In Bulletin No. 245 of this Station an investigation was reported of some of the chemical changes that take place in milk when it undergoes ordinary souring. The points then studied were the decrease of sugar, the formation of lactic acid, the curdling of milk in relation to acid, and the action of acid upon the calcium caseinate in milk.

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The special purpose of the present study has been to learn what chemical changes take place in the insoluble and soluble constituents of milk when souring under ordinary conditions. This work has been carried out with the use of the method previously employed by us in studying the condition of casein and salts in milk.[1] Briefly stated, the method separates milk into a soluble portion and an insoluble portion, making use of a porous porcelain filter as the means of separation; and the chemical composition of each portion is determined.

Our study of the chemical changes taking place in the constituents of milk as the result of souring originated several years ago in connection with a study of problems relating to the manufacture and ripening of cheese, especially the American cheddar cheese, which is the type that has been most largely made in this country. The first work was carried out also in connection with a study of cottage, or sour-milk, cheese. In the manufacture of most kinds of cheese, the early stages are largely associated with the formation of lactic acid, the amount of acid being governed especially according to the character or type of the cheese made. We thus have in the case of different kinds of cheese the common process of lactic-acid fermentation; the chemical changes resulting are essentially the same in kind, whether the amount of acid is small or large, but are, of course, more extensive in proportion as the amount of acid increases. As might readily be supposed, the control of the lactic-acid fermentation plays a very important role in the manufacturing processes of all types of cheese.

We have carried out numerous experiments in studying the changes that take place in milk as a result of souring and the results have been in uniform agreement. We shall, therefore, instead of presenting all of our data, give such as will fully illustrate the ascertained facts. We will first give the analytical results obtained with milk at the end of 60 hours and then a set of results obtained at frequent intervals during a period of 96 hours.

CHANGES IN MILK IN SOURING.

AFTER 60 HOURS.

Before considering the detailed changes that are produced in the constituents of milk during the various stages of progressive souring, we will show the final changes that take place when the souring process has practically been completed, which under ordinary conditions should be in about 60 hours.

Four liters of fresh milk divided into two portions, of two liters each, were treated as follows: One portion was treated with chloroform at once and passed through a porous porcelain filter. The

[1] N. Y. Agr. Expt. Sta., Tech. Bul. 39. 1914.

second lot was allowed to sour at room temperature after inoculation with a culture containing *Bacterium lactis acidi* and *B. lactis aerogenes.* At the end of 60 hours, this was filtered through a porous porcelain filter. Analysis was made of the fresh milk, of the serum of the fresh milk and of the serum of the sour milk, the results of which are given in the following table:

TABLE I.— CHANGES IN CONDITION OF MILK CONSTITUENTS AS A RESULT OF SOURING.

(After 60 hours.)

CONSTITUENTS.	Original milk 100 c.c.	SERUM FROM FRESH MILK.		SERUM FROM SOUR MILK.	
		Serum 100 c.c.	Percentage of milk constituents in serum.	Serum 100 c.c.	Percentage of milk constituents in serum.
	Grams.	*Grams.*	*Per ct.*	*Grams.*	*Per ct.*
Sugar	5.75	5.75	100.00	4.48	....
Casein	3.07	0.00	0.00	0.00	0.00
Albumin	0.506	0.188	37.15	0.506	100.00
Nitrogen in other compounds	0.049	0.049	100.00	0.049	100.00
Citric acid	0.237	0.237	100.00	0.000	*0.00
Phosphorus (inorganic)	0.087	0.056	64.40	0.090	100.00
Calcium	0.144	0.048	33.33	0.148	100.00
Magnesium	0.013	0.007	53.85	0.014	100.00
Potassium	0.120	0.124	100.00	0.120	100.00
Sodium	0.055	0.057	100.00	0.058	100.00
Chlorine	0.076	0.081	100.00	0.079	100.00
Ash	0.725	0.400	55.17	0.690	†95.17
Lactic acid	0.00	0.00	0.00	1.124	‡.......

* During the process of souring the citric acid is completely changed by the action of *B. lactis aerogenes* into acetic acid and carbon dioxide, as shown by Bosworth and Prucha. (N. Y. Agr. Expt. Sta. Tech. Bul. No. 14, 1910.)

† In determining the total ash of milk, the organic phosphorus of the casein is included in the ash as phosphoric acid, but in the serum this organic phosphorus is not present and therefore the amount of ash in serum from sour milk is less than that in milk.

‡ Some of the lactic acid is adsorbed by the casein (Van Slyke, L. L., and Van Slyke, D. D. N. Y. Agr. Expt. Sta. Tech. Bul. 3. 1906) and therefore not all of it is found in the serum.

A study of the results in Table I shows in general that the main effects produced by the souring of milk are the conversion of more or less milk-sugar into lactic acid, which causes precipitation of casein and makes soluble the other insoluble constituents. Stated in more detail, we notice the following results:

(1) The amount of sugar in milk is decreased through the action of the lactic-acid bacteria. In this case, there is a loss of 1.27 grams

for 5.75 grams of sugar per 100 c.c. of milk, or 22 per ct. The amount of lactic acid formed is 1.124 grams; 88.5 per ct. of the sugar decomposed is converted into lactic acid.

(2) The citric acid of milk completely disappears, being decomposed into acetic acid and carbon dioxide by the action of *B. lactis aerogenes*.

(3) Those inorganic constituents of normal milk that are insoluble are made soluble by the acid resulting from bacterial action.

(4) The albumin, part of which in normal milk fails to pass through a porous porcelain filter, is so changed in sour milk as to pass completely through such a filter.

(5) Calcium caseinate of normal milk is completely converted into the free protein, uncombined with any base, which is precipitated, and calcium lactate is formed, soluble in the serum.

AT DIFFERENT STAGES OF SOURING.

In addition to the ultimate changes, it is desirable to know something of the rate of chemical change taking place when milk sours. We have carried on numerous sets of experiments but present here the results of only one, which is typical of all under the same conditions.

The milk used in this experiment was fresh morning milk which had been pasterized and run through a separator to remove fat. The milk was inoculated with a pure culture of *B. lactis acidi* and kept at a temperature of about 90° F. (32.2° C.), samples being taken for analysis at intervals and chloroformed at once in order to prevent further bacterial action. Sampling began after the milk had stood four hours and continued at intervals of an hour or less for 16 hours; after 24 hours, samples were taken every 24 hours up to the end of 96 hours.

The constituents to which attention was given are the following: (1) Sugar, (2) lactic acid, (3) acidity, before and after passing through porcelain filter, (4) nitrogen in serum, (5) nitrogen as albumin in serum, (6) soluble and insoluble inorganic phosphorus, (7) soluble and insoluble calcium and magnesium, (8) calcium as di-calcium phosphate, (9) calcium derived from calcium caseinate.

The methods by which the amounts of total, soluble and insoluble calcium, magnesium and phosphorus were obtained have been fully described in our previous work referred to above.

Considerable time was devoted to attempts to determine separately the amounts of free lactic acid and combined lactic acid, but no satisfactory method could be devised for making such distinction in the presence of acid phosphates. This is due to the conditions existing in sour milk where we have present acid calcium phosphate and calcium lactate and, in advanced stages of souring, some free lactic acid. Extraction of a solution containing lactates in the

presence of acid phosphates results in the following reaction, which gives an apparent quantity of free lactic acid much greater than the actual amount:

$$CaH_4P_2O_8 + Ca(C_3H_5O_3)_2 = 2CaHPO_4 + 2HC_3H_5O_3.$$

In a solution containing free lactic acid, lactates and phosphates undergo mutual reaction, forming free lactic acid and di-calcium phosphate. While we find it possible to extract with ether all the free lactic acid from a solution containing these compounds, we are unable to tell with accuracy at what point the conversion of lactate into free acid begins. It is possible by extraction to remove the lactic acid of the lactate completely from a solution containing calcium lactate and acid calcium phosphate, provided the phosphate is present in excess, but we have thus far found no satisfactory way of making a separate determination of free lactic acid in the presence of these salts by extraction. We hope, however, to do this later by determination of the free hydrogen ions.

Before giving the results of the work for the sour milk in its various progressive stages of change, we give below a statement of the compounds present in the fresh milk previous to souring, as a convenience for reference in interpreting subsequent data.

TABLE II.— COMPOSITION OF FRESH MILK BEFORE SOURING.

	Grams in 100 c.c.		Grams in 100 c.c.
Nitrogen, total	0.5964	Calcium, total	0.1571
" as casein	0.4704	" soluble	0.0427
" " albumin	0.0762	" insoluble	0.1144
" other than casein and albumin	0.0498	" " as $CaHPO_4$	0.0515
" in serum	0.0770	" " combined with protein	0.0629
Phosphorus, total	0.1039	Magnesium, total	0.0158
" in casein	0.0211	" soluble	0.0112
" inorganic	0.0828	" insoluble	0.0046
" " soluble	0.0429		
" " insoluble	0.0399		

We will present the results of our investigation under the following divisions:

1. Conversion of milk-sugar into lactic acid in the souring of milk.
2. Effect of souring of milk upon acidity of milk and milk-serum.
3. Effect of souring of milk upon insoluble calcium and inorganic phosphorus.
4. Effect of souring of milk upon milk-albumin.

Conversion of milk-sugar into lactic acid in the souring of milk.— In the table below we give (1) the amount of sugar in the milk when fresh and at intervals up to the end of 96 hours and (2) the amount

of lactic acid found. The lactic acid was determined by extraction with ether and conversion into zinc lactate.

TABLE III.— FORMATION OF LACTIC ACID IN SOURING OF MILK.

AGE OF MILK WHEN SAMPLED.	GRAMS IN 100 C.C. OF MILK			Percentage of fermented sugar converted into lactic acid.
	Sugar.	Amount of sugar changed.	Lactic acid.	Per ct.
Fresh	5.30	....	0.000	....
10 hours	5.07	0.23	0.200	87
12 "	4.83	0.47	0.330	70
14 "	4.68	0.62	0.513	82
19 "	4.58	0.72	0.671	93
25 "	4.42	0.88	0.665	75.5
48 "	4.30	1.00	1.052	....
96 "	4.26	1.04	1.124	....

The fermentation of the milk-sugar, under the conditions of the experiment, is slow during the initial period but between the 10th and 25th hours most of the change occurs. With increase of lactic acid beyond 0.7 per ct., bacterial activity is much reduced. Between the 48th and 96th hours, only slight change in sugar takes place. Attention is called to the apparent discrepancy at 48 and 96 hours in the relation of the amount of lactic acid found to the amount of sugar decomposed. Apparently more acid is formed than can be accounted for by the amount of sugar fermented. This is due to the fact that the acetic acid produced by the fermentation of the citric acid is extracted by ether and weighed with the lactic acid.

In the last column of Table III we give the proportion of fermented milk-sugar that was changed into lactic acid. The proportions vary from 70 to 93 per ct. It is known that products other than lactic acid are formed, varying in kind and amount according to the conditions of the fermentation process.

Effect of souring of milk upon acidity of milk and milk-serum.—In the following table we give (1) the amount of total acidity in the fresh milk and that found at intervals during the process of fermentation; (2) the amount of acids in the serum; (3) the amount of acids in the portion of the milk that does not pass through the porous porcelain filter; and (4) the amount of lactic acid.

The acidity of the insoluble part of the milk is obtained by difference. The amount or degree of acidity, in the case of the milk and milk-serum, is expressed in terms of $\frac{N}{10}$ alkali required to produce neutrality to phenolphthalein, after removal of calcium by neutral

potassium oxalate. The amount of lactic acid was determined by extraction and conversion into zinc lactate.

After 12 hours the milk curdled and the acidity could not be satisfactorily determined by titration. The figures given in Table IV, column 2, for total acidity in milk after 12 hours are obtained by adding 10 (the amount of acid in the fresh milk) to the amount of lactic acid found by direct determination. The figures in column 4 under acidity of "insoluble portion" of milk and in column 5 under "increase of acidity in milk" after 12 hours are based also upon the calculated amount of total acidity.

TABLE IV.— ACIDITY OF MILK, MILK-SERUM, ETC.

AGE OF MILK WHEN SAMPLED. (1)	ACIDITY EXPRESSED AS AMOUNT $\frac{N}{10}$ ALKALI REQUIRED TO NEUTRALIZE 100 C. C. OF MILK.				
	In milk. (2)	In serum. (3)	In insoluble portion. (4)	Increase of acidity in milk. (5)	Lactic acid. (6)
	C.c.	*C.c.*	*C.c.*	*C.c.*	*C.c.*
Fresh	10.0	7.8	2.2	....	....
4 hours	12.0	8.2	3.8	2.0	1.7
5 "	14.0	9.6	4.4	4.0	3.8
6 "	15.6	10.0	5.6	5.6	5.3
7 "	19.6	11.8	7.8	9.6	9.2
8 "	21.0	13.6	7.4	11.0	10.9
9 "	26.0	15.6	10.4	16.0	15.7
10 "	33.0	17.0	16.0	23.0	22.0
11 "	37.0	20.6	16.4	27.0	26.7
11½ "	42.4	24.0	18.4	32.4	31.3
12 "	47.6	27.0	20.6	37.6	36.6
13 "	*55.6	30.2	*25.4	*45.6	45.6
13½ "	62.0	30.2	31.8	52.0	52.0
14 "	67.1	32.0	35.1	57.1	57.1
25 "	84.0	41.6	42.4	74.0	74.0
48 "	127.0	53.6	73.4	117.0	117.0
72 "	133.0	59.0	74.0	123.0	123.0
96 "	135.0	62.4	72.6	125.0	125.0

* As explained in the text above, the figures expressing total acidity in milk from 13 to 96 hours inclusive are obtained by calculation, owing to the curdling of the milk.

Attention is called to the following points connected with the results given in Table IV: (1) Increase of total acidity in milk. There is an increase of acidity in the milk; this is more or less rapid for the intervals of the first 24 hours; the increase during the second 24 hours is much less than during the first, and after 48 hours further increase is insignificant. The acidity of fresh milk is due to acid phosphates. The increase is due to the production of lactic acid

resulting from the bacterial decomposition of milk-sugar. This is clearly shown by a comparison of the last two columns, in which the figures representing the increase of acidity in milk run closely parallel with those representing the amount of lactic acid obtained by direct determination.

(2) Acidity of serum.— The acidity of the serum increases during the whole observed period of 96 hours, but the increase is relatively small after the first 24 hours. The increase of acidity in the milk-serum is due to the increased formation of lactic acid in the milk. We should expect, owing to the solubility of the compounds producing acidity, to find the increase of acidity in the serum closely equal to the amount of increase of lactic acid. However, a comparison of the figures in columns 4 and 6 shows that the amount of acid in the serum does not increase as rapidly as lactic acid. The explanation that most readily suggests itself for this condition is that there is adsorption of the acid compounds by the particles of precipitated casein, as shown by L. L. Van Slyke and D. D. Van Slyke in Technical Bulletin No. 3 (1907) this Station.

(3) Acidity of insoluble portion.— During the process of souring, the calcium is removed from the calcium caseinate of milk and the resulting form of casein is able to neutralize alkali. The de-calcified casein constitutes the portion of the insoluble part of milk that possesses acid properties but, owing to its property of adsorbing acids, the insoluble part of souring milk, prepared by the method of filtration through a porous porcelain filter, shows a higher acidity than that due to the base-combining power of the de-calcified casein.

Effect of souring milk upon insoluble calcium and inorganic phosphorus.— The insoluble calcium in fresh milk is in combination (1) with phosphoric acid as $CaHPO_4$ and (2) with casein as Ca_4 caseinate. With the formation of lactic acid, the di-calcium phosphate is converted into mono-calcium phosphate ($CaH_4P_2O_8$) and the calcium caseinate is changed, first, into caseinates containing less calcium and, finally, into uncombined casein. In the table following we give for different intervals of the process of souring the following determinations: (1) Insoluble calcium, total, (2) in combination as $CaHPO_4$, (3) in calcium caseinate, (4) amount of calcium as $CaHPO_4$ that is dissolved, (5) calcium in calcium caseinate dissolved, (6) insoluble inorganic phosphorus, and (7) inorganic insoluble phosphorus dissolved. The values given for fresh milk are obtained from Table II.

In studying the data in Table V, we call attention to the following summary of the results:

(1) Insoluble calcium and phosphorus in combination as $CaHPO_4$ begin to go into solution as $CaH_4P_2O_8$ and calcium lactate in a few hours and the action continues with increasing rapidity most of the time until the solution is complete in 13½ hours under the conditions of the experiment.

(2) The insoluble calcium in combination with casein does not appear to be acted upon by the lactic acid as quickly as does that in $CaHPO_4$. A comparison of columns 5 and 6 shows the comparative rate of solution for the calcium in these two forms of combination. The calcium in calcium caseinate is not completely converted into calcium lactate until the fermentation has been going on about 24 hours. Broadly speaking, the calcium in $CaHPO_4$ is acted upon about twice as rapidly as that in calcium caseinate during the first 12 hours under the conditions of our experiments.

TABLE V.— PROPORTIONS OF INSOLUBLE CALCIUM AND INORGANIC PHOSPHORUS DISSOLVED IN SOURING OF MILK.

AGE OF MILK WHEN SAMPLED.	INSOLUBLE CALCIUM IN 100 C. C. OF MILK.			PERCENTAGE OF INSOLUBLE CALCIUM IN MILK DISSOLVED IN CASE OF		Insoluble inorganic phosphorus in 100 c.c. of milk.	Percentage of insoluble inorganic phosphorus dissolved.
	Total.	In combination as $CaHPO_4$.	In combination as caseinate.	$CaHPO_4$	Caseinate.		
	Grams.	*Grams.*	*Grams.*			*Grams.*	
Fresh.....	0.1144	0.0515	0.0629	....	....	0.0399	....
4 hours..	0.1102	0.0470	0.0632	8.7	00.0	0.0364	8.7
5 " ..	0.1090	0.0457	0.0633	11.2	00.0	0.0354	11.2
6 " ..	0.1041	0.0431	0.0610	16.3	3.2	0.0334	16.3
7 " ..	0.0974	0.0418	0.0556	18.8	11.7	0.0324	18.8
8 " ..	0.0922	0.0374	0.0548	27.4	13.0	0.0290	27.4
9 " ..	0.0775	0.0319	0.0456	38.0	27.6	0.0247	38.0
10 " ..	0.0648	0.0255	0.0393	50.5	37.6	0.0198	50.5
11 " ..	0.0560	0.0180	0.0380	65.0	39.7	0.0140	65.0
12 " ..	0.0368	0.0049	0.0319	90.5	....	0.0038	90.5
13 " ..	0.0191	0.0019	0.0172	96.3	72.7	0.0015	96.3
13½ " ..	0.0154	0.0000	0.0154	100.0	75.5	0.0000	100.0
15 " ..	0.0092	....	0.0092	....	85.4	....	....
19 " ..	0.0088	....	0.0088	....	86.0	....	....
25 " ..	0.0000	....	0.0000	....	100.0	....	....

It may be added here that determinations of insoluble magnesium were also made. The results show that the insoluble magnesium goes into solution completely in 11½ hours, which is somewhat sooner than the insoluble calcium in $CaHPO_4$.

Effect of souring of milk upon milk-albumin.— In Table II the per ct. of nitrogen as albumin in the milk used in our experiments is given as 0.0762 gram per 100 c.c. of milk; the per ct. of nitrogen in forms other than casein and albumin is 0.0498 gram, and the per ct. of nitrogen in serum is 0.0770 gram per 100 c.c. of milk. The amount of nitrogen in the serum includes that in forms other than casein and albumin, and the amount of this nitrogen subtracted

from the nitrogen found as albumin in milk gives the amount ot albumin in the serum (0.0272 gram). The amounts of total nitrogen and of albumin nitrogen in serum have been determined at intervals during the souring of milk and the results are given in the following table.

TABLE VI.— NITROGEN IN SERUM AND RELATION TO ALBUMIN.

AGE OF MILK WHEN SAMPLED.	Total nitrogen in serum from 100 c.c. of milk.	Percentage increase of nitrogen in serum.	Nitrogen as albumin in serum from 100 c.c. of milk.	Percentage of albumin of milk in serum.
	Grams.		*Grams.*	
Fresh	0.0770	....	0.0272	35.7
10 hours	0.0950	23.4	0.0452	60.0
11 "	0.0970	26.0	0.0472	62.0
12 "	0.1120	45.5	0.0622	81.6
13 "	0.1180	53.2	0.0682	90.0
14 "	0.1270	65.0	0.0772	00.0

The significant point that attracts attention in connection with the data in Table VI is the increase of nitrogen in the serum. This increase is due to albumin since there was no solution of casein under the conditions of our work. The formation of lactic acid is apparently responsible for this change. The change may be due to decrease of adsorption of albumin by casein consequent upon the change produced in casein from caseinate to uncombined protein or it may be due to combination of base with albumin in milk and a gradual separation of base and protein in much the same manner as in case of casein.

CONCERNING THE UTILIZATION OF INOSITE IN THE ANIMAL ORGANISM.*†

R. J. ANDERSON.

SUMMARY.

This bulletin contains a report of experiments which were made with the object of determining the utilization of inosite in the animal organism.

The first part deals with the effect of inosite upon the respiratory exchange of a dog. These experiments showed that inosite is not utilized to any extent by the dog. It is not stored or oxidised in the body but the greater portion is excreted unchanged. When given per os at the rate of 2 grams per kilo of body weight it does not cause a rise in the respiratory quotient. As much as 77 per ct. of the amount given may be recovered from the excreta.

Inosite is absorbed very slowly from the intestine, hence it causes a more or less severe diarrhea. As a result it is largely eliminated with the feces and only a small portion is excreted by the kidneys.

The second part deals with the effect of inosite upon the metabolism of man. It is shown that when inosite is taken at the rate of about 0.5 gram per kilo of body weight per day it produces some diarrhea at first or frequent soft stools. After a few days the stools, although more frequent than usual, are nearly of normal cons stency.

Except for the increased excretion of creatinine in the after period, for which we can now offer no explanation, we find that the ingestion of inosite has no marked or appreciable effect upon the general metabolism of man.

About 9 per ct. of the inosite taken per os is eliminated unchanged in the urine, but none in the feces. In what manner the balance, or about 91 per ct., of the inosite is utilized we have not been able to determine.

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* Two papers read before the section of *Biological Chemistry* at the Urbana meeting of the American Chemical Society, April 20, 1916.

† A reprint of Technical Bulletin No. 54, May, 1916.

I. CONCERNING THE EFFECT OF INOSITE UPON THE RESPIRATORY EXCHANGE IN THE DOG.[1]

R. J. ANDERSON.

INTRODUCTION.

In connection with the investigations concerning the occurrence and chemical properties of phytin and inosite phosphoric acids[2] and the physiological rôle of these substances, we have undertaken a few experiments to determine the fate of inosite and its utilization in the animal organism. The previous work on phytin in this laboratory[3] concerned itself chiefly with the physiological relation of the phytin phosphorus to the metabolism. In the present paper we deal with the organic radical, inosite, of the phytin molecule.

The wide distribution of inosite in the vegetable and animal kingdoms has led to many investigations concerning the physiological function of this substance in the animal organism. Since inosite was first discovered in muscle by Scherer[4] it has been found in practically all of the tissues and fluids of the body[5] and it appears to be a normal constituent of the urine.[6] In the vegetable kingdom, inosite is also widely distributed, occurring free in many plants and, particularly, conjugated with phosphoric acid as phytin or inosite hexaphosphoric acid[7] in seeds, roots or tubers.

The earlier investigators[8] sought to establish some relation of inosite to the carbohydrates and to the elimination of sugar in diabetes. Külz[9] in an extensive series of experiments examined both normal and diabetic subjects. He found normal human urine practically free from inosite but from the urine of six normal males after excessive drinking of beer or wine he obtained from 0.4 to 0.9 grams of inosite. After feeding from 30 to 50 grams of inosite

[1] The experimental work herein reported was carried out in the Institute of Physiology, University College, London.

[2] R. J. Anderson, *Journ. Biol. Chem.* 11:471; 12:97; 12:447; 13:311 (1912); 17:141; 18:425; 18:441 (1914); 20:463; 20:475; 20:483; 20:493 (1915), and N. Y. Station Tech. Buls. 19, 21, 22, 25 (1912); 32, 36 (1914); 40 (1915).

[3] Jordan, Hart and Patten, *Am. Journ. Physiol.* 16:268 and N. Y. Sta. Tech. Bul. 1. A. R. Rose, N. Y. Sta. Tech. Bul. 20.

[4] Scherer, Liebig's *Annalen* 73:322 (1850).

[5] A review of the literature will be found in Meyer u. Jacobson, Lehrbuch. d. organ. Chem. Bd. II, Thiel I, 1902, p. 807.

[6] Hoppe-Seyler, Handbuch d. Chem. Analyse, 7 aufl. p. 220. E. Starkenstein, *Ztschr. exper. Pathol. u. Therapie*, 5:378 (1908).

[7] A review of literature is given by A. R. Rose, *Biochem. Bul.* 2:21 (1912).

[8] See E. Starkenstein, loc. cit., for review of the literature.

[9] E. Külz, Sitzungsberichte d. Ges. z. Beförd. d. ges. Naturwissen. Marburg. 1875 and 1876. Beiträge z. Pathol. u. Therapie d. Diabetes Mellitus. Bd. 1, 1874.

to normal individuals he was able to recover only from 0.2 to 0.5 gram of inosite from the urine. In the case of diabetics the same quantity of inosite gave practically the same result and there was no increase in the elimination of sugar. He thought, for this reason, that inosite might be utilized in the diabetic organism as a source of energy in place of sugar. By experiments on rabbits he also showed that inosite did not give rise to the formation of glycogen.

These studies were later continued by Mayer.[10] His results confirm those reported by Külz concerning the nonformation of glycogen from inosite. After feeding from 2 to 15 grams of inosite per os to rabbits, only small amounts, from 2 to 2.4 per ct., of the substance were recovered from the urine. When it was given subcutaneously, however, he found that from 26 to 51 per ct. of the inosite was eliminated unchanged in the urine. In addition to the inosite small quantities of lactic acid [11] were sometimes isolated from the urine after the inosite had been given subcutaneously.

Results very similar to the above were reported about the same time by Starkenstein.[12] About 5 per ct. of the inosite given per os to rabbits was recovered in the urine. When the substance was injected subcutaneously about 42 per ct. and after intravenous injections about 50 per ct. of the inosite were eliminated in the urine. This author concludes that inosite is a normal cell constituent; that it is only slightly oxidised in the body because a large percentage of it is eliminated unchanged in the urine after being given in subcutaneous or intravenous injections and that disappearance of inosite given per os is not permissible as proof of its being oxidised by the body since it may be destroyed by bacteria in the intestine.

It is evident from the work which has been done on this subject that inosite given per os is either largely destroyed by bacteria in the intestine or else it is stored or oxidised in the body, because very small amounts of it are eliminated in the urine. In the hope of throwing some further light upon the fate of inosite in the animal organism we have carried out some respiration experiments with a dog which, in a fasting condition, was fed inosite per os just previous to being placed in the respiration apparatus. If inosite were oxidised in the body in the same manner as the carbohydrates or dextrose, for instance, then a rise in the respiratory quotient should be observed. The experiments have shown however, that there was no appreciable rise in the respiratory quotient after giving 10 grams of inosite. It is evident, therefore, that inosite is not oxidised in the dog in the manner of dextrose and if oxidation or other changes take place it is slowly and in such a way as not to effect the respiratory quotient during the first two hours following its ingestion.

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[10] P. Mayer, *Biochem. Ztschr.* 2:393 (1907).
[11] P. Mayer, *Biochem. Ztschr.* 9:533 (1908).
[12] E. Starkenstein, *Ztschr. exper. Pathol. u. Therapie,* 5:378 (1908).

It was observed, about two or three hours after the inosite had been given, that considerable diarrhea set in. Unfortunately it was not possible to separate the urine and the liquid excreta;— these were therefore examined together. In one case, however, the liquid feces were voided outside of the metabolism cage and the urine was collected quite clear. When this clear urine was examined it was found to contain but 0.4 gram of inosite. This shows, as in the case of man reported by Külz [13] and rabbits reported by Mayer [14] and Starkenstein,[15] that but small amounts of inosite are eliminated through the kidneys of the dog. When the urine was mixed with liquid feces, however, very large quantities of inosite were obtained, and in one case as much as 77 per ct. of the amount given was recovered from the mixed excreta.

EXPERIMENTAL PART.

The inosite used in this work was prepared from crude phytin by hydrolyzing this substance with dilute sulphuric acid in an autoclave. It was carefully purified by repeated recrystallization from water. The snow-white product finally obtained was free from ash and it melted at 220 degrees (uncorrected.)

A small bitch weighing 5,700 grams was selected for these experiments and trained for use in the respiration apparatus. The animal was kept in a metabolism cage and fed once a day, in the evening, on cooked meat and dog biscuit, but during the period when inosite was given meat was the sole food.

The Benedict respiration apparatus described by Moorhouse, Patterson and Stephenson [16] was used. The carbon dioxide and oxygen measurements were made as there described and for particulars we refer to the above paper.

The animal was fed late in the afternoon, about five o'clock, and the respiration observations were made about eighteen hours afterwards. The quotients in this fasting condition are given in Table I. The figures obtained lie within the limits usually observed under these conditions.

The inosite was given dissolved in about 70 c.c. of warm water. This solution was taken at first just as readily as one of glucose but after a while the inosite solution was absolutely refused and it had to be given by the stomach tube. A few minutes after the inosite had been given the animal was placed in the respiration apparatus and the observation periods varied from 1½ hours to about 2 hours. It will be noticed by referring to the figures in Table II that the respiratory quotients during these periods are slightly higher than

[13] E. Külz — loc. cit.
[14] P. Mayer — loc. cit.
[15] E. Starkenstein — loc. cit.
[16] Moorhouse, Patterson and Stephenson, *Biochem. Journ.* 9:176 (1915).

those in the fasting condition, Table I. The difference is very slight, however, and it is doubtful if the small rise in the respiratory quotient is due to oxidation of the inosite. The animal showed signs of discomfort during the inosite periods and was more or less restless, consequently the oxygen measurement was more difficult. Diarrhea usually set in a short time after the animal was removed from the respiration apparatus.

TABLE I.— FASTING RESPIRATORY QUOTIENTS OF DOG.

DATE.	Length of period.	CO_2c.c. per minute.	O_2c.c. per minute.	Respiratory quotient.	Remarks.
Feb. 11......	42 minutes.	40.35	54.61	0.739	Usual movements.
" 12......	64 "	44.62	58.65	0.760	Somewhat restless.
" 15......	58 "	42.03	55.72	0.754	" "
" 24......	46 "	35.95	45.65	0.787	Very quiet.

TABLE II.— RESPIRATORY QUOTIENTS OF DOG AFTER GIVING 10 GRAMS OF INOSITE.

DATE.	Length of period.	Co_2c.c. per minute.	O_2c.c. per minute.	Respiratory quotient.	Remarks.
Feb. 11......	90 minutes.	45.18	57.73	0.782	More or less restless
" 12......	126 "	44.72	56.50	0.791	" " " "
" 15......	123 "	44.13	56.50	0.780	" " " "
" 17......	111 "	43.38	58.08	0.747	" " " "

For comparison with the quotients tabulated above some figures, after feeding glucose, are given in Table III.

TABLE III.— RESPIRATORY QUOTIENTS OF DOG AFTER FEEDING GLUCOSE.

DATE.	Glucose.	Length of period.	CO_2c.c. per minute.	O_2c.c. per minute.	Respiratory quotient.	Remarks.
Feb. 9....	20 grams.	63 minutes.	59.77	60.84	0.982	Restless.
" 18....	10 "	78 "	65.20	66.02	0.989	"

In Table IV are given the amounts of inosite [17] recovered from the urine and liquid feces. In this connection it must be stated that only the liquid portion of the excreta which collected in the bottle underneath the metabolism cage was analyzed for inosite.

TABLE IV.— INOSITE RECOVERED FROM URINE AND LIQUID FECES OF DOG.

Experiment	Inosite given	Inosite recovered	Percentage inosite recovered	Remarks.
	Grams.	*Grams.*	*Per ct.*	
1	10	0.40	4.0	Urine clear.
2	10	4.00	40.0	Urine plus feces.
3	10	1.27	12.7	" " "
4	10	2.25	22.5	" " "
5	10	6.30	63.0	" " "
6	10	7.70	77.0	" " "
1st day } 2nd " }	None	0.20	....	Urine clear.
3rd "	None....	Trace....	....	" "

The variation in the amounts of inosite recovered in the first four experiments is due no doubt to the fact that in these periods the dog was used for the respiration observations and shortly after being removed from the respiration apparatus diarrhea set in and these liquid stools were lost. During the 5th and 6th experiments, however, the dog was kept in the metabolism cage the whole time and all of the liquid feces and the urine were collected together.

After the 6th experiment the clear urine was collected for the next three days, and analyzed for inosite. By referring to the table it will be noticed that the combined urine of the 1st and 2nd day contained only 0.2 grams of inosite while on the 3rd day a mere trace was obtained. This shows that practically all of the insoite given is eliminated within twenty-four hours; evidently, therefore, either none or very little of it can be stored in the body.

Since the clear urine, Table IV, contained very little and the urine plus liquid feces contained very much inosite it would seem that by far the greater portion of the substance was not absorbed but that it was eliminated through the bowel. In order to determine to what extent inosite is absorbed in the intestine the following experiment was made: A section about two feet long of the small intestine of a dog was exposed [18] and washed out with physiological salt solution. One end was ligatured and a solution of 3 grams of inosite in 50 c.c. of warm water was introduced and the other end was also ligatured.

[17] The inosite was isolated by the method of P. Mayer, *Biochem. Ztschr.* 2:398, (1907).

[18] The operation was performed by Prof. E. H. Starling.

The whole was replaced in the abdominal cavity, the incision loosely closed and the animal kept under chloroform for two hours. On removing the section of the bowel it was quite distended and it contained 90 c.c. of liquid. From this liquid 2.95 grams of inosite were isolated, i. e., the substance was recovered practically quantitatively.

The author takes pleasure in acknowledging his indebtedness to Prof. E. H. Starling for help and advice in carrying out the above experiments and to Dr. V. H. K. Moorhouse for assistance in using the respiration apparatus.

II. THE EFFECT OF INOSITE UPON THE METABOLISM OF MAN.

R. J. ANDERSON AND A. W. BOSWORTH.

INTRODUCTION.

The objects of this investigation were to determine whether the ingestion of inosite has any noticeable influence upon the metabolism of man measurable in terms of the nitrogen and phosphorus excretion and also the fate of inosite in the human body and its channels of elimination.

It has been shown by one of us[1] that inosite is not utilized to any extent by the dog, that it acts as a strong purgative and that the greater portion is eliminated unchanged through the bowel.

That inosite causes more or less severe diarrhea in both man and animals when given in large quantities has been observed previously by Külz[2] who thought that the diarrhea was caused by the transformation of the inosite into lactic acid in the intestine. In normal or diabetic human subjects from 30 to 50 grams of inosite per day caused considerable diarrhea and only from 0.2 to 0.5 gram of the inosite was recovered from the urine. This author does not report the examination of the feces of his subjects for inosite. In the case of rabbits the above author found that inosite caused diarrhea and only small quantities of the substance were recovered from the urine. Results very similar to the above have been reported by Mayer[3] and Starkenstein,[4] who both used rabbits as subjects.

Of the previous investigations concerning the physiological rôle of inosite in man those of Külz (l. c.) are probably the most thorough and he had an unusually large quantity of inosite at his disposal for experimental purposes, having prepared about a pound of it from green beans. The extremely high price and the small available quantities of inosite have presented great difficulties in carrying out investigations with this substance. We prepared several hundred grams of pure inosite for the present work by hydrolyzing crude phytin with dilute sulphuric acid in an autoclave. The substance was purified by repeated recrystallization from water. The snow-white crystalline product finally obtained was free from ash and melted at 220 degrees (uncorrected).

Our results confirm those of previous investigators that inosite given per os disappears and only small quantities are eliminated in the

[1] R. J. Anderson; see preceding article.
[2] E. Külz, Sitzungsberichte d. Ges. z. Beförd d. ges. Naturwissen. Marburg, 1875–1876.
[3] P. Mayer, *Biochem. Ztschr.* 2:393, (1907).
[4] E. Starkenstein, *Ztschr. f. exper. Pathol. u. Therapie* 5:378 (1908).

urine. Külz (l. c.) recovered only about 0.9 per ct. of the inosite given from the urine of human subjects. Our figures, however, are about ten times greater, i. e., we recovered from the urine nearly 9 per ct. of the ingested inosite. Careful examination of the feces was made but we failed to obtain a trace of inosite. Consequently the urine is the only channel of elimination of inosite in man.

In what manner the balance, about 91 per ct., of the inosite is utilized or destroyed is uncertain. It has been shown by the investigations of Meillère [5] and also Starkenstein [6] that inosite is destroyed by the colon bacillus. It has also been shown by Hilger [7] and Vohl [8] that inosite is transformed into lactic acid by the bacteria found in putrid cheese. Experiments by Starkenstein [9] indicate that inosite is destroyed by autolytic ferments of muscles and the liver with the simultaneous increase of lactic acid.

Our results do not show whether the inosite was destroyed by bacteria in the intestine or underwent oxidation in the body. If the inosite was changed into lactic acid it is evident that only traces of it were excreted as such because there was no appreciable increase of ammonia in the urine, Table III. At present we can only record the fact that of the inosite given only about 9 per ct. escaped destruction and was recovered from the urine.

It is evident from the data presented in the experimental part that, except for the increased excretion of creatinine in the after period, the ingestion of inosite at the rate of about 0.5 gram per kilo of body weight has no appreciable influence upon the metabolism of man.

EXPERIMENTAL PART.

To determine the channels of elimination of inosite in man we carried out the following preliminary experiment. One of us (A. W. B.) received 30 grams of inosite dissolved in water in three equal portions during the day. The following morning a solution of 10 grams of inosite was given. About four hours after the first 10 grams of inosite were taken a very loose watery stool was passed and during the twenty-four hours there were three more very watery stools. The second day the stools were almost of normal consistency. During the first and second day the subject complained of an uneasy or uncomfortable feeling and of a peculiar sensation in the chest and abdominal muscles. This feeling disappeared towards the end of the third day and on the fourth day he felt normal again.

The urine and feces were collected in 24-hour periods and examined for inosite. For the isolation of the inosite we used the method of Mayer [10] which is briefly as follows: The urine was evaporated to

[5] Meillère, *Compt. rend. d. la Soc. de Biol.* 1907, p. 1096.
[6] E. Starkenstein, loc. cit.
[7] Hilger, Liebigs *Annalen*, 160:333.
[8] Vohl, *Ber. d. d. chem. Ges.* 9:984, (1876).
[9] E. Starkenstein, loc. cit.
[10] P. Mayer, *Biochem. Ztschr.* 2:398 (1907).

about one-fourth of its volume and precipitated with excess of lead acetate. After standing a short while the precipitate was filtered off on a Buchner funnel and washed with water. The filtrate was heated to boiling and precipitated with excess of basic lead acetate and finally rendered strongly alkaline with concentrated ammonia. After standing for 24 hours the precipitate was filtered on a Buchner funnel and washed with water. It was then suspended in water and decomposed with hydrogen sulphide. After removing the lead sulphide, the filtrate was evaporated on the water-bath almost to dryness. The residue was taken up in a little hot water, decolorized with animal charcoal, again evaporated to small bulk, transferred to an Erlenmeyer flask and brought to crystallization by the addition of about 10 volumes of absolute alcohol. After the greater portion of the inosite had crystallized out ether was added until the solution turned cloudy and the whole was allowed to stand in the icebox over night. The crystals were then filtered off, washed with alcohol and ether, dried in the air, and weighed.

The feces were examined as follows: The fresh material was stirred up with water until of uniform consistency. Lead acetate was then added and after standing for some time it was filtered and washed. The filtrate was evaporated, precipitated with basic lead acetate, etc., as mentioned above.

The amount of inosite recovered in the excreta is given below in Table I.

TABLE I.—INOSITE RECOVERED FROM FECES AND URINE OF MAN.

DAY.	Amount of inosite given.	Inosite recovered from the urine.	Percentage of inosite recovered in the urine.	Inosite recovered from the feces.
	Grams.	*Grams.*	*Per ct.*	
1	30	2.6	8.66	None.
2	10	1.1	11.00	None.
3	None.	Trace.	....	None.

The results show that in man a small quantity of the ingested inosite is eliminated in the urine and that the feces contain none; also that it is either absorbed and oxidised in the body or else destroyed in the intestine and that the excretion of unchanged inosite is complete n 24 hours because on the third day the urine contained only a trace of the substance. We find that the quantity of inosite excreted by the kidneys is about 10 times greater than found by Külz. This is probably due to the improved method of isolating the substance.

In a second more extensive experiment we have sought to discover if the ingestion of inosite produced any change or disturbance in the metabolism. For this purpose we selected a period of eight days during which the food of the subject (A. W. B.) was carefully regulated. Unfortunately we failed to maintain any control of the food intake during the days following the actual experiment or after period. The results are vitiated also by the fact that the period over which our experiment extended was not of sufficient length to bring the subject to a condition of nitrogen equilibrium and that we analyzed only one sample of each article of food. Since it was a liberal and mixed diet consisting of meat, eggs, milk, potatoes, bread, etc., it is very probable that the actual intake during the whole period was different from what we figured from the result of one analysis. Despite these drawbacks we feel justified in publishing briefly the results obtained because these results are negative, i. e. our observations have failed to reveal any noteworthy or striking change in the general metabolism as a result of the ingestion of inosite.

During this second experiment which was begun a few months after the first one reported above, we began the inosite period by giving only 15 grams of the substance the first day. On the second and subsequent days 30 grams of inosite were given. In this way the uncomfortable diarrhea was avoided. The stools were more frequent and softer than usual but towards the end of the period they were nearly of normal consistency. There were no feelings of discomfort or distress, in fact the subject felt practically normal throughout the experiment, performing his laboratory work in the usual manner.

The total nitrogen and phosphorus balance, with the caution mentioned above, is given in Table II. The difficulty of bringing man to a nitrogen equilibrium and the fact that the diet gave a nitrogen intake quite a little below the usual average daily intake of the subject makes the minus nitrogen and phosphorus balance have no special significance.

Figures covering the elimination of nitrogen in the urine are tabulated in Table III. There was a considerable rise in the creatinine output which began on the last day of the inosite period and extended through the whole of the after period, the first two days of the after-period showing a marked increase in creatinine elimination. During the after period the subject ate the same diet as during the rest of the experiment but the food was not accurately weighed. In view of this fact, the increased creatinine output during the after period would seem to be an important observation and a matter well worthy of further study.

The uric acid, creatinine and ammonia were determined by the Folin methods.

TABLE II.— TOTAL NITROGEN AND PHOSPHORUS BALANCE.

	PRELIMINARY PERIOD.				INOSITE PERIOD.			
Day	1	2	3	4	5	6	7	8
Grams nitrogen, intake	15.254	15.483	11.781	12.131	12.880	11.355	11.151	11.249
Grams nitrogen, outgo	15.018	13.602	14.233	12.667	13.943	11.682	13.147	11.821
Grams phosphorus, intake	1.832	1.708	1.362	1.384	1.592	1.318	1.323	1.330
Grams phosphorus, outgo	2.1267	1.6626	1.8688	1.5634	1.8469	1.4029	1.5119	1.4680

Total nitrogen intake preliminary period	54.649 grams.
Total nitrogen outgo preliminary period	55.520 "
Minus nitrogen balance	0.871 "
Total phosphorus intake preliminary period	6.286 "
Total phosphorus outgo preliminary period	7.2215 "
Minus phosphorus balance	0.9355 "
Total nitrogen intake inosite period	46.635 "
Total nitrogen outgo inosite period	50.593 "
Minus nitrogen balance	3.958 "
Total phosphorus intake inosite period	5.563 "
Total phosphorus outgo inosite period	6.2297 "
Minus phosphorus balance	0.6667 "

The phosphorus elimination in the urine is recorded in Table IV. The total phosphorus was determined after destroying the organic matter by the Neumann method. The inorganic phosphorus is that quantity which was directly precipitated by ammonium molybdate after acidifying the urine with nitric acid and adding ammonium nitrate. The organic phosphorus was found by difference. It will be noticed by referring to the table that the organic phosphorus varied from 0 to 0.0178 gram with an average of 0.0102 gram per day. This agrees with the average quantity of organic phosphorus usually found in normal urine.[11]

The amount of nitrogen and phosphorus excreted in the feces is tabulated in Table V. A notable rise in the nitrogen excretion is observed during the inosite period. This was no doubt due to the more frequent stools and consequent less complete absorption in the intestine. Since it was shown in the preliminary experiment that inosite was only eliminated in the urine the feces were not examined this time for this substance.

[11] For review of the literature, see E. B. Forbes and M. H. Keith, Ohio Agric. Exp. Sta. Tech. Bul. 5, p. 190. 1914.

TABLE III.— URINE EXCRETION AND NITROGEN ELIMINATION.

	Preliminary Period.				Inosite Period.				After Period.			
Day	1	2	3	4	5	6	7	8	9	10	11	12
Volume of urine, c.c	1,420	1,480	1,170	710	770	810	1,450	900	1,175	1,390	1,550	1,070
Sp. G	1.019	1.015	1.020	1.028	1.026	1.026	1.016	1.022	1.022	1.022	1.016	1.023
Total nitrogen, grams	12.908	12.802	12.273	11.204	11.504	9.914	11.296	9.234	12.009	13.232	8.680	8.988
Uric acid, grams	0.636	0.658	0.585	0.546	0.550	0.463	0.520	0.692	0.628	0.731	0.620	0.767
Creatinine, grams	1.198	1.199	1.050	1.150	1.299	1.010	1.068	1.448	1.729	2.183	1.141	1.332
Ammonia nitrogen, grams	0.965	0.864	0.959	0.899	1.089	0.868	1.125	0.918	0.940	0.970	0.639	0.683

TABLE IV.— ELIMINATION OF PHOSPHORUS IN THE URINE.

	Preliminary Period.								Inosite Period.							
Day	1		2		3		4		5		6		7		8	
Volume of urine, c.c.	1,420		1,480		1,170		710		770		810		1,450		900	
	Per ct.	*Grams.*	*Per ct.*	*Grams.*	*Per ct.*	*Grams.*	*Per ct.*	*Grams.*	*Per ct.*	*Grams.*	*Per ct.*	*Grams.*	*Per ct.*	*Grams.*	*Per ct.*	*Grams.*
Total phosphorus	0.0835	1.1857	0.0843	1.2476	0.0946	1.1068	0.1433	1.0174	0.1370	1.0549	0.1174	0.9509	0.0742	1.0759	0.1030	0.9270
Inorganic phosphorus	0.0826	1.1729	0.0831	1.2298	0.0946	1.1068	0.1413	1.0032	0.1358	1.0456	0.1165	0.9436	0.0738	1.0701	0.1014	0.9126
Organic phosphorus	0.0009	0.0128	0.0012	0.0178	0	0	0.0020	0.0142	0.0012	0.0093	0.0009	0.0073	0.0004	0.0058	0.0016	0.0144

TABLE V.— NITROGEN AND PHOSPHORUS EXCRETION IN THE FECES.

	Preliminary Period.				Inosite Period.			
Day	1	2	3	4	5	6	7	8
Nitrogen, grams	2.110	0.800	1.960	1.463	2.439	1.768	1.851	2.587
Phosphorus, grams	0.941	0.415	0.762	0.546	0.792	0.452	0.436	0.541

In Table VI the daily intake of inosite and the quantities recovered from the urine are recorded. The same method of isolation was used as before. The inosite was excreted in about the same proportion as in the preliminary experiment. The total intake amounted to 105 grams of inosite and only about 9 grams were recovered. The balance, 96 grams, was either oxidised in the body or destroyed by bacteria in the intestine. Evidently the inosite could not have been stored in the body because the elimination ceases with the intake.

TABLE VI.— INOSITE INTAKE AND OUTGO.

Day	5	6	7	8	9	10	11	12
Volume of urine, c.c.	770	810	1,450	900	1,175	1,390	1,550	1,070
Inosite intake, grams	15	30	30	30	None	None	None	None
Inosite excreted, grams	0.38	2.5	3.19	2.5	0.47	Trace	Trace	Trace

Total intake = 105 grams of inosite.
Inosite recovered = 9.04 grams or 8.6 per ct.

CONCERNING CERTAIN AROMATIC CONSTITUENTS OF URINE.*

R. J. ANDERSON.

SUMMARY.

I. It has been shown that the so-called neutral oil obtained from cow urine consists for the greater part of p-cresol. Mixed with this, however, there is present a very small percentage of an aromatic non-phenolic oil of agreeable odor having the composition $C_{10}H_{16}O$. This substance is present in larger amount during the summer than in the winter. The non-phenolic oils excreted during the winter are not chemically identical with those eliminated during the summer. The nature of these substances apparently depends upon the nature of the terpene-like bodies contained in the feed which the animals obtain.

The substance called "Urogon" by Mooser is a mixture of p-cresol and the above non-phenolic neutral oils.

The "Urogol" of Mooser we have shown to give the same derivatives as p-cresol and hence we believe that "Urogol" and p-cresol are identical.

Attention is called to the difficulty of removing phenols from an ethereal solution of phenols and non-phenolic oils by extraction with aqueous alkali.

II. The experimental data show that the neutral oil obtained from goat urine, which was described under the name of "Urogon" by Fricke, is a mixture.

The oil contains principally p-cresol mixed with a small percentage of a non-phenolic volatile oil, the composition corresponding to the formula $C_{10}H_{16}O$.

Both of these substances are identical with the oils isolated from cow urine.

III. From horse urine a neutral alkali-insoluble oil was isolated which had the composition corresponding to the formula $C_7H_{12}O$.

Human urine was found to contain an oil of similar composition and properties to the one above.

These oils possess an agreeable terpene-like odor, but owing to the very small yield we have been unable to identify them.

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I. THE NON-PHENOLIC VOLATILE OILS OF COW URINE.

INTRODUCTION.

It has been known for a long time that the distillates from acidified urine contain, in addition to volatile acids, phenol, cresols, etc., certain non-phenolic or neutral volatile oils. The object of the present investigation was to isolate and identify these substances or at least to determine more closely than has been done heretofore the properties and composition of these terpene-like volatile oils obtainable from the urine of various animals. This paper deals with the substances isolated from the neutral oil, the so called " Städelers Oel " and the products described by some authors as " Urogon " and " Urogol " obtained from cow urine.

This neutral oil was first observed and described by Städeler[1] as early as 1851 in his investigations regarding the volatile constituents of cow urine. The above author reports that the yellow oily liquid finally obtained after distilling concentrated urine acidified with hydrochloric acid was treated with strong potassium hydroxide which left a slight oily residue. This alkali-insoluble oil was removed by distilling the strongly alkaline liquid with steam.

The oil is described as having an agreeable odor resembling that of rosemary or origanum. It contained large quantities of nitrogen and it was soluble with a red color in concentrated sulphuric acid. The aqueous solution or suspension gave no color reaction with ferric chloride and it was not precipitated by basic lead acetate. The same author states that he had observed the occurrence of similar alkali-insoluble oils in the distillates from horse urine and human urine but in the latter it was present in very minute quantities.

Various later investigators like Hoppe-Seyler,[2] Baumann,[3] and Brieger,[4] have reported the occurrence of similar alkali-insoluble oils in the distillates from the urine of various animals. Of course we concern ourselves here only with the occurrence of these volatile oils in normal urine. The literature dealing with the metabolism and excretion of aromatic and terpene-like substances is so voluminous that it merely can be indicated in this place.[5]

Although several investigators, as mentioned above, had observed neutral alkali-insoluble oils in normal urines these substances had never been examined carefully or analyzed by anyone, so far as we are aware, until a few years ago, when Mooser,[6] to whose work

[1] G. Städeler. *Ann. Chem.*, 77:17. 1851.
[2] Hoppe-Seyler. Handbuch d. physiol. u. pathol. chem. Analyse. 1875, p. 109.
[3] E. Baumann. *Pflügers Arch. Physiol.* 13:285. 1876.
[4] L. Brieger. *Ztschr. physiol. Chem.* 4:204. 1880.
[5] See C. Neuberg. Der Harn, 1911, and Hammarsten's Physiological Chemistry for references to the literature on the subject.
[6] W. Mooser. *Ztschr. Physiol. Chem.* 63:155. 1909.

reference must be made, reported a study of the aromatic substances of the urine. This author investigated particularly the neutral oil, the so called "Städelers Oel." This oil was obtained from cow urine as follows: The concentrated urine was acidified with sulphuric acid and distilled until the distillate did not react with Millon's reagent. The distillates were united, mixed with calcium carbonate and again subjected to distillation in an atmosphere of carbon dioxide. This second distillate was made *slightly* alkaline with potassium hydroxide and extracted with petroleum ether. The neutral oil isolated from this solution was washed several times with water and for further purification was treated in 20 gram portions with 20 c. c. of 10 per ct. potassium hydroxide; again taken up in petroleum ether and finally distilled in vacuum. The resulting distillate was a slightly yellow, strongly refractive oil of unpleasant odor which crystallized in needles when chilled in solid carbon dioxide. It was free from nitrogen and in composition it agreed with the formula C_7H_8O.

This oil which the above author named "Urogon" is isomeric with cresol as it has the composition C_7H_8O, but for some reason it is believed to be different from cresol and is supposed to contain the -CO- group although it did not give any of the reactions characteristic of the carbonyl group. In composition and properties it agrees closely with cresol but in spite of these facts it is considered to be a new and definite individual substance. In the hands of the above author this "Urogon," on treatment with potassium hydroxide, yielded two new compounds called "Urogol" and "Urogen."

When the crude oil "Urogon" was treated with sufficiently concentrated potassium hydroxide practically all of it went into solution with the exception of a small quantity of oil which had a pleasant terpene- or cymol-like odor. From the alkaline solution a phenol was isolated which had the composition C_7H_8O and which is called "Urogol." Although this substance had all the properties of, and the same composition as, cresol it is nevertheless believed to be different and isomeric with cresol. By the action of potassium hydroxide on "Urogon" there was also formed a hydrocarbon $C_{21}H_{42}$ called "Urogen."

This author apparently permitted the small quantity of oil of pleasant terpene-like odor which remained on treating "Urogon" with potassium hydroxide to escape his attention and examination. This is the more strange since this particular alkali-insoluble portion of the distillate is the oil referred to by Städeler.

The work of Mooser has been extended and augmented by Fricke [1] who claims to have found the substance "Urogon" in the urine of most domestic animals as well as in human urine. It must be noted, however, that the above author felt satisfied in identifying "Urogon"

[1] Ernest Fricke. *Pflügers Arch. Physiol.* 156:225. 1914.

by the smell and a few chemical reactions such as the red color developed with concentrated sulphuric acid and with Millon's reagent and that the substance reacted neutral to litmus and did not reduce Fehling's solution. In no case does he report the purification and analysis of any substance.

Neuberg[1] mentions briefly that he did not succeed in preparing the substance " Urogon " in pure form and Neuberg and Czapski[2] throw doubt upon the existence of any such substance. These authors do not report any investigation of urine for " Urogon " but base their doubt of its existence upon the fact that both phenol and cresol may be extracted from an alkaline aqueous solution with petroleum ether. For this reason they hold that the oil called " Urogon " by Mooser and Fricke as well as the " Urogol " of Mooser must have consisted chiefly of cresol.

As a result of our work we have found that the neutral oil called " Urogon " by Mooser is a mixture consisting principally of p-cresol, but containing a small percentage of a non-phenolic volatile oil having the composition $C_{10}H_{16}O$ and consequently isomeric with camphor. The various details of the isolation and purification will be fully described in the experimental part.

The phenol called " Urogol " by Mooser obtained from the " Urogon " by treatment with concentrated alkali possesses all the properties of p-cresol and yields derivatives identical with those of p-cresol, hence we do not believe that there is any room for doubt regarding the identity of these substances.

The reason why cresol occurs in the residual neutral oil is due to the fact, as pointed out by Neuberg and Czapski,[3] that cresol is only slightly soluble in dilute alkali. As will be shown in the experimental part we have found it impossible completely to extract all of the cresol even by 20 per ct. sodium hydroxide from an ethereal solution of the mixed oils obtained on distilling urine.

The non-phenolic oil, $C_{10}H_{16}O$, mentioned above, is light yellow in color and possesses an agreeable terpene- or essential oil-like odor. When acted upon by semicarbazide hydrochloride in glacial acetic acid solution it yields a crystalline semicarbazone melting at 165°. The substance, consequently, contains the carbonyl group and is either an aldehyde or a ketone. This was rather unexpected since similar compounds containing only the carbonyl group when introduced into the animal organism become hydroxylated and are then eliminated as conjugated glucuronic acids.[4] One would expect, therefore, that a substance such as the one under consider-

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[1] C. Neuberg. Der Harn, 1: (1911) p. 518.

[2] C. Neuberg u. L. Czapski. *Biochem. Ztschr.* 67:28. 1914.

[3] C. Neuberg u. L. Czapski. l. c.

[4] Compare the works of O. Schmiedeberg u. H. Meyer. *Ztschr. physiol. Chem.* 3:422. 1879; E. Sundvik. Akademisk Afhandling, Helsingfors, 1886; E. Fromm u. H. Hildebrandt, *Ztschr. physiol. Chem.* 33:579. 1901.

ation, which must have been excreted in conjugated form, would have contained the hydroxyl group.

In this connection the experiments described by Fromm, Hildebrandt and Clemens,[1] "Über das Verhalten des Camphens im Thierkörper," are interesting. These authors after feeding camphene to rabbits isolated a conjugated glucuronic acid from the urine which on distilling with sulphuric acid gave a volatile oil of the composition $C_{10}H_{16}O$. After purifying over the bisulphite compound this substance crystallized and was found to be identical with camphenilan aldehyde. They believed, therefore, that camphene must be oxidized in the body to a di-hydroxyl compound which is eliminated as a conjugated glucuronic acid. On cleavage the di-hydroxyl compound easily splits off water giving the aldehyde.

It is probable that the oil $C_{10}H_{16}O$ which we have isolated from cow urine had been eliminated in the same way and that the hydroxyl groups had been split off during the distillation with the sulphuric acid. The above oil is present in urine in very small quantity and the amount at our disposal did not permit of a complete investigation and we have not been able to identify the substance.

It would seem, however, that the above oil is not a constant metabolic product since the oil isolated from the urine during the winter, although it had the same composition, did not give a crystalline semicarbazone. Evidently, therefore, the nature of the non-phenolic oils excreted in the urine depends upon the nature of the terpene-like substances contained in the feed.

EXPERIMENTAL PART.

Mixed urine from a herd of cows was collected during the summer while the animals were part of the time in pasture. The fresh urine was concentrated to about one-eighth of its volume and then strongly acidified with sulphuric acid and distilled with steam until no more oil went over. The distillate was made strongly alkaline with sodium hydroxide and extracted with several portions of ether. The ethereal solution was further shaken for some time with dilute sodium hydroxide and after that with dilute sulphuric acid and finally washed with water. After drying with sodium sulphate the ether was evaporated and the residue distilled in vacuum. From 127 liters of urine 38.75 grams of oil were obtained.

The light yellow oil was of neutral reaction on litmus paper and it possessed an extremely unpleasant penetrating odor which resembled the peculiar smell of a cow stable. It contained neither nitrogen nor sulphur. With concentrated nitric acid it reacted with great violence. When shaken with concentrated sodium or potassium hydroxide the disgusting odor disappeared and an agreeable terpene-like odor resulted. Bromine was readily absorbed with liberation

[1] E. Fromm, H. Hildebrandt, u. P. Clemens. *Ztschr. physiol. Chem.* 37:189. (1902-03).

of hydrobromic acid. It was soluble in all proportions in all the organic solvents and in concentrated sulphuric acid it dissolved with a red color. It was insoluble in concentrated hydrochloric acid or in ammonia. It did not reduce Fehling's solution but an ammoniacal solution of silver nitrate was reduced on heating.

On analysis the following result was obtained:

0.1988 gm. subst. gave 0.1365 gm. H_2O and 0.5630 gm. CO_2.
Found: C = 77.24; H = 7.68 per ct.

Molecular weight determinations were made by the freezing point method using benzene as solvent and the following figures obtained:

	1.	2.
Weight of substance =	0.2042 gm.	0.2364 gm.
Weight of benzene =	16.3229 gm.	15.1615 gm.
Depression =	0.524°	0.661°
Mol. wt. =	117.	115.

The properties, reactions, composition and molecular weight correspond with those described by Mooser (l. c.) for the neutral oil from cow urine to which he gave the name "Urogon."

This oil, however, was not a homogeneous substance but could be separated into two fractions. After fractionating in high vacuum three times the first portion of the final distillate which embraced about 75 per ct. of the total oil went over between 68–69° at 0.5 mm. pressure.

The residues from these distillations were reserved for further examination.

The product obtained, as above, was a practically colorless oil slightly heavier than water and it had a distinctly phenolic but not unpleasant odor. Its aqueous solution gave a fine blue coloration with ferric chloride. With concentrated nitric acid it reacted with great violence and it dissolved in concentrated sulphuric acid with a red color. It was completely soluble in concentrated sodium or potassium hydroxide. When cooled in a freezing mixture of ice and salt it crystallized to a white solid mass.

It gave the following result on analysis:

0.1852 gm. subst. gave 0. 1263 gm. H_2O and 0.5244 gm. CO_2.
Found: C = 77.22; H = 7.63 per ct.

The substance crystallized, as already mentioned, when it was cooled in a freezing mixture. When some of these crystals were introduced into the oil previously cooled to 13° practically the whole substance changed slowly into massive prisms. For the removal of traces of adhering oil the crystals were pressed between filter paper. There remained a snow white mass of crystals which melted at 21°, and it boiled at atmospheric pressure at 198.5° (uncorrected.)

This crystalline substance was analyzed.

O.1457 gm. subst. gave O. 0967 gm. H_2O and 0.4140 gm. CO_2.
Found: C = 77.49; H = 7.42 per ct.
For cresol, C_7H_8O = 108. Calculated: C = 77.77; H = 7.40 per ct.

It will be noticed from the above analyses that both the oil and the crystalline substance have the same composition. The substance is identical with the "Urogol" of Mooser but it is evident from the above analyses that it is also either identical or isomeric with cresol. Despite the low melting point we believe that it is nearly pure p-cresol for the reasons to be shown below.

Its solubility in concentrated alkali and its blue coloration with ferric chloride indicated its phenolic nature and it gave no reactions characteristic of aldehyde or ketone groups, i. e. it gave no crystalline derivatives with phenylhydrazine, sodium bisulphite, hydroxylamine or semicarbazide hydrochlorides.

It gave, however, two bromine substitution products corresponding to mono and di-brom cresol. The di-brom compound had the same melting point as given for di-brom p-cresol.

BROMINATION OF THE SUBSTANCE.

Preparation of the monobrom derivative.—The oil, 2.7 grams (1 mol), was dissolved in 50 c.c. of chloroform and to it was added 4 grams (1 mol) of bromine dissolved in 25 c.c. of chloroform. The bromine color disappeared immediately and much hydrobromic acid was given off. The chloroform solution was washed several times with water to remove the hydrobromic acid and then dried with sodium sulphate and the chloroform distilled off. An oily residue remained of intensely penetrating odor. It did not solidify in a freezing mixture. In vacuum at 3 mm. pressure it boiled at 80°–81°. It was obtained as a colorless, highly refractive, heavy oil which rapidly darkened when exposed to the light. The yield was 3.4 grams which corresponds to 74 per ct. of a monobrom derivative.

The substance was analyzed at once.

1. 0.1586 gm. subst. gave 0.0530 gm. H_2O and 0.2609 gm. CO_2.
2. 0.1615 gm. subst. gave 0.0591 gm. H_2O and 0.2688 gm. CO_2.
   0.1825 gm. subst. gave 0.1817 gm. AgBr.

Found: 1. C = 44.86; H = 3.73; Br = 42.37 per ct.
2. C = 45.39; H = 4.09 per ct.
For mono-brom cresol, C_7H_7BrO = 186.9.
Calculated: C = 44.94; H = 3.74; Br = 42.75 per ct.

Preparation of the di-brom derivative.—This was easily formed by the action of four grams (2 mol) of bromine upon 1.35 grams (1 mol) of the oil in chloroform solution. The bromine color disappeared immediately until about one-half of the bromine had been

added but after that more slowly. After standing for three hours at room temperature the bromine color had disappeared. The hydrobromic acid was then washed out with water and the chloroform solution dried with sodium sulphate. After evaporating the chloroform in vacuum there remained a light yellow colored oil which immediately crystallized when placed in a freezing mixture.

The crystals were extremely soluble in all of the ordinary organic solvents but insoluble in water and it was found impossible to recrystallize the substance from any of the above solvents. On the spontaneous evaporation of the solvents, however, the substance separated in crystalline form, some of the crystals being delicate colorless needles or prisms over an inch long.

The substance was finally recrystallized as follows: It was dissolved in chloroform and placed in an open crystallizing dish and the chloroform evaporated in a vacuum desiccator. The crystalline substance which remained was separated mechanically from the dark colored portion and recrystallized in the same manner. From this second recrystallization there were obtained 1.7 grams of practically colorless crystals.

When slowly heated the substance melted between 48°–49° (uncorrected). According to Beilstein the crystalline di-brom p-cresol melts at 48°–49°.

A larger quantity of the substance was prepared and recrystallized from ligroin. This also melted between 48° and 49°.

The following result was obtained on analysis:
0.2070 gm. subst. gave 0.0433 gm. H_2O and 0.2382 gm. CO_2.
0.1702 gm. subst. gave 0.2425 gm. AgBr.
Found: $C = 31.38$; $H = 2.34$; $Br = 60.63$ per ct.
For dibrom cresol $C_7H_6Br_2O = 265.8$.
Calculated: $C = 31.60$; $H = 2.25$; $Br = 60.12$ per ct.

Judging by melting point and composition the above crystalline substance is pure di-brom p-cresol.

In order to determine if the substance would take up more than two atoms of bromine the following experiment was carried out: To 1.35 grams (1 mol) of the oil in 50 c.c. of chloroform was added 6 grams (3 mol) of bromine in 25 c.c. of chloroform. This was allowed to stand for three hours at room temperature. The color at the end of this time was deep brown showing the presence of bromine. The chloroform was washed with water to take up the hydrobromic acid and the excess of bromine was removed by shaking with a solution of sodium bisulphite. The chloroform solution was again washed with water and finally dried with sodium sulphate. After evaporating the chloroform the oily residue crystallized on cooling in ice water. After dissolving in chloroform and transferring to a tared crystallizing dish the chloroform was evaporated at room temperature in a vacuum desiccator. After drying in vacuum over sulphuric acid

the crystals weighed 3.4 grams which is equal to about 100 per ct. yield of the di-brom p-cresol. This behavior of taking up only 2 atoms of bromine under ordinary conditions is characteristic of o- and p-cresol while the meta-cresol under like conditions takes up 3 atoms of bromine.[1]

It would seem from the properties and composition of the above oil and particularly those of the bromine derivatives just described that the substance in question is cresol and apparently nearly pure p-cresol. The substance is also by its method of preparation and its properties identical with the product named "Urogol" by Mooser. Evidently, therefore, this designation is superfluous since the substance possesses all the properties and reactions of p-cresol.

EXAMINATION OF THE OILY RESIDUES REMAINING AFTER ISOLATING THE P-CRESOL.

The residues were united and repeatedly fractionated in vacuum when there was finally obtained a small amount of a light yellow oil of agreeable terpene-like odor. It did not react with cold concentrated nitric acid but the oil turned reddish, then violet and finally deep purple in color. On heating with concentrated nitric acid it dissolved without any visible reaction and on diluting with water a cloudy solution resulted. In concentrated sulphuric acid it dissolves with a red color. It is insoluble in concentrated sodium or potassium hydroxide even on boiling but the oil turns dark in color. After shaking with water the aqueous solution gives no reaction with ferric chloride. It is very soluble in all of the ordinary organic solvents but insoluble in water. The aqueous suspension of the oil reduces ammoniacal silver nitrate on heating. Potassium permanganate solution is decolorized when added to the oil suspended in water. In chloroform solution bromine is absorbed at once with liberation of hydrobromic acid.

The oil went over at 102° at about 1 mm. pressure.

On analysis the following result was obtained:

0.1538 gm. subst. gave 0.1490 gm. H_2O and 0.4413 gm. CO_2.
Found: $C = 78.25$; $H = 10.84$ per ct.

The oil was dissolved in a little ether and thoroughly shaken with 20 per ct. sodium hydroxide for some time. After washing with water the ethereal solution was dried with sodium sulphate, the ether evaporated and the oily residue distilled in vacuum. At 1 mm. pressure the oil went over at the same temperature as before, viz. at 102°. It weighed 2.5 grams. It had the same appearance, odor and properties as before treatment with sodium hydroxide.

[1]Meyer u. Jacobson. Lehrbuch der Organ. Chem. II Band, I Theil, p. 379.

On analysis it gave the following results:
0.1608 gm. subst. gave 0.1599 gm. H_2O and 0.4652 gm. CO_2.
Found: C = 78.90; H = 11.12 per ct.
The composition agrees fairly well with the formula $C_{10}H_{16}O$.
For $C_{10}H_{16}O$ = 152, Calculated: C = 78.94; H = 10.52 per ct.

ATTEMPTS TO PREPARE CRYSTALLINE DERIVATIVES FROM THE OIL $C_{10}H_{16}O$.

The substance did not react with phenylisocyanate and consequently it cannot contain an —OH group. It gave no crystalline derivatives with phenylhydrazine hydrochloride and it did not react with sodium bisulphite.

A crystalline semicarbazone, however, was obtained as follows: 0.76 gm. of the oil was dissolved in 10 c.c. of glacial acetic acid and to it was added 0.6 gram of semicarbazide hydrochloride and 0.8 gram of sodium acetate dissolved in 2 c.c. of water. The solution was allowed to stand for two days at room temperature. It was then diluted with water and the oil which separated was extracted with ether. The ethereal solution was shaken with dilute sodium hydroxide to remove acetic acid and then dried over sodium sulphate. After evaporating the ether, the oily residue was transferred to a crystallizing dish with ether and the latter evaporated in a vacuum desiccator. The oil which remained crystallized nearly completely on standing. The crystals were freed from adhering oil as much as possible by pressing between filter paper and then recrystallized from benzene from which it separated in plates. It was again recrystallized by dissolving in a little methyl alcohol and adding hot water until the solution turned cloudy. On cooling, the substance separated in colorless plates. After standing in the ice box over night the crystals were filtered off, washed in 50 per ct. methyl alcohol and water and then dried at 100°. The product was snow white and was practically odorless and it weighed about 0.1 gram. When slowly heated it melted at 165° (uncorrected). It was analyzed after drying at 105° in vacuum over phosphorus pentoxide when it did not lose in weight.

0.0798 gm. subst. gave 0.0692 gm. H_2O and 0.1838 gm. CO_2.
For $C_{10}H_{16}$: N· NH·CO·NH_2 = 209.
Calculated: C = 63.15; H = 9.09; N = 20.09 per ct.
Found: C = 62.82; H = 9.70 per ct.

Unfortunately we were unable to make any further tests to determine the nature or constitution of this neutral oil on account of lack of material — most of the substance having been used up in making preliminary experiments. There appears, however, to be no doubt that the neutral non-phenolic oil obtained from cow urine during the summer is isomeric with camphor having the composition $C_{10}H_{16}O$.

FURTHER PREPARATION OF THE NON-PHENOLIC VOLATILE OIL FROM COW URINE.

About 430 liters of mixed urine from a herd of cows were collected during the winter, from February 29th to March 25th. The fresh urine was evaporated and distilled as before. The distillates were extracted with ether. The ethereal solutions were vigorously shaken with three separate portions of 20 per ct. sodium hydroxide and then with dilute sulphuric acid and finally washed with water. After drying with sodium sulphate the ether was evaporated and the oily residue distilled in vacuum. There were obtained 8.2 grams of a light yellow oil of a penetrating, not unpleasant, odor. The aqueous solution gave no reaction with ferric chloride, but it reacted slightly with concentrated nitric acid which indicated the presence of phenols. For further purification the oil was transferred to a distilling flask with a little ether and vigorously shaken with 20 per ct. sodium hydroxide and finally distilled with steam.

The light yellow oil which went over was extracted with ether, dried with sodium sulphate and after filtering and evaporating the ether the residue was fractionated.

The alkaline liquid above, remaining after distilling with steam, was extracted with ether and then acidified with sulphuric acid. The oily substance which separated was taken up with ether, the latter dried and evaporated and the residue distilled. The oil went over at about 76° and 2 mm. pressure. It weighed 2.7 grams. It was a practically colorless oil of distinct phenolic odor. With concentrated nitric acid it reacted with great violence. It was completely soluble in concentrated alkali. The aqueous suspension gave a fine blue coloration with ferric chloride. When cooled in a freezing mixture of ice and salt the oil crystallized to a white mass. All of these reactions indicate that the substance was cresol. It is evident from this how difficult it is to extract all of the phenols or cresols from an ethereal solution even with 20 per ct. sodium hydroxide.

The volatile oil mentioned above after distilling over sodium hydroxide was further fractionated which yielded two principal fractions. Fraction 1 showed the same boiling point as the cresol and weighed 1 gram. It was a light yellow oil of pleasant ethereal and non-phenolic odor. It gave no reaction with ferric chloride and did not react with concentrated nitric acid. It was insoluble in concentrated alkali. Neither nitrogen nor sulphur could be detected.

It gave the following results on analysis:

0.1285 gm. subst. gave 0.1219 gm. H_2O and 0.3523 gm. CO_2.
Found: $C = 74.77$; $H = 10.61$ per ct.
This agrees nearly with tetra-hydrocresol $C_7H_{12}O = 112$.
Calculated: $C = 75.00$; $H = 10.71$ per ct.

An attempt was made to prepare a derivative with phenylisocyanate as follows: 0.56 gram of the oil was mixed with 0.60 gram of phenylisocyanate in a dry test tube which was immediately sealed. It was gently warmed for a short time and allowed to stand at room temperature over night. A considerable amount of colorless crystals had then separated. In the hope of completing the crystallization the tube was heated on the water bath for several hours. All the crystals had then dissolved and it was found impossible to induce the formation of any further crystallization in the solution, even on standing for several weeks not a single crystal formed. The small available quantity of the oil prevented any further examination.

Fraction 2 of the above neutral oil went over at about 100° at 0.25 mm. pressure. This portion weighed 2.5 grams and so far as color, odor and reactions were concerned it seemed to be identical with the non-phenolic oil $C_{10}H_{16}O$, previously described in this paper. It also had the same composition and it was free from nitrogen and sulphur.

0.1592 gm. subst. gave 0.1489 gm. H_2O and 0.4571 gm. CO_2.
Found: $C = 78.30$; $H = 10.46$ per ct.
For $C_{10}H_{16}O = 152$, Calculated: $C = 78.94$; $H = 10.52$ per ct.

Although this oil had the same percentage composition as the product isolated from cow urine during the summer, it was different in that it did not give a crystalline semicarbazone. After acting upon the substance with semicarbazide hydrochloride in the same way as before an oil was obtained which did not crystallize and on distillation in high vacuum nearly one-half of the original oil was recovered unchanged as it boiled at the same temperature and it had the same composition.

Found: $C = 79.15$; $H = 10.49$ per ct.

A considerable residue remained in the distillation flask. It was a sticky, non-crystallizable syrup which contained a large quantity of nitrogen. It was probably a condensation product with semicarbazide but it did not crystallize itself nor could it be brought to crystallization in any of the usual solvents.

It would seem, then, that a portion of the non-phenolic oil excreted during the winter, although it has the same percentage composition, differs in constitution from the oil excreted during the summer. In addition, the winter urine contained an oil having a lower boiling point and a lower carbon content than that obtained in the summer.

We believe for this reason that the nature of the terpene-like substances contained in the feed condition the nature and composition of the volatile oils excreted in the urine. If this view is correct it is not surprising that the non-phenolic volatile oils excreted in the urine during the winter differ from those which are excreted in the summer when a part of the ration consists of green grass.

It also follows that the non-phenolic oils of the urine are not constant metabolic products but that their nature to a large extent will depend upon the nature of the mother substances contained in the feed and are consequently of minor importance in the animal metabolism.

II. THE NON-PHENOLIC VOLATILE OILS OF GOAT URINE.

INTRODUCTION.

It has been shown in a previous report from this laboratory[1] that the neutral oil, the so called "Urogon" of Mooser[2] isolated from the distillates of acidified cow urine consists principally of p-cresol mixed with a very small percentage of a non-phenolic volatile oil having the composition represented by the formula $C_{10}H_{16}O$, thus confirming the opinion expressed by Neuberg and Czapski[3] that "Urogon" was not a homogeneous substance but a mixture consisting largely of p-cresol. Since it has been claimed by Fricke[4] that the distillates from goat urine yield a neutral oil identical with "Urogon," we have also prepared and examined the neutral oil obtained from this source.

The goat urine was concentrated and distilled in the same way as the cow urine and the oil was isolated in the same manner. By treatment with 20 per ct. sodium hydroxide this neutral oil or "Urogon" was separated into two portions — the alkali soluble and the alkali insoluble.

The alkali soluble portion was found to be identical in every respect with p-cresol. It combined with phenylisocyanate giving a crystalline compound which had the composition and melting point required for p-cresol urethane and by the action of nitric acid the 3.5 dinitro p-cresol was also formed. These derivatives in addition to the reactions and properties of the substance itself leaves no doubt that it was p-cresol.

The alkali-insoluble portion of the crude neutral oil was found to be identical in every particular with the non-phenolic oil isolated from cow urine. It had the same appearance and odor and in composition it agreed with the formula $C_{10}H_{16}O$. This oil gave a crystalline semicarbazone when acted upon with semicarbazide hydrochloride in glacial acetic acid solution which in crystal form and solubilities was identical with the semicarbazone obtained from the oil from cow urine and like the latter it melted at 165°.

It is evident, therefore, that the neutral oils or "Urogon" isolated from cow and goat urine are identical and that they consist of a

[1] R. J. Anderson. See preceding article.
[2] W. Mooser. *Ztschr. physiol. Chem.* 63:155. 1909.
[3] C. Neuberg u. L. Czapski. *Biochem. Ztschr.* 67:28. 1914.
[4] Ernest Fricke. *Pflügers Arch. Physiol.* 156:225. 1914.

mixture containing principally p-cresol with a small percentage of a non-phenolic volatile oil having the composition expressed by the formula $C_{10}H_{16}O$.

EXPERIMENTAL PART.

The urine was collected during the summer when the animals were fed on green alfalfa, hay, oats and corn meal. After evaporating the fresh urine to about one-eighth of its volume it was strongly acidified with sulphuric acid and distilled, partly direct and partly with steam until no further oil appeared in the distillate. The distillates were transferred to a large separating funnel and rendered strongly alkaline with sodium hydroxide and then extracted several times with ether. The ethereal solutions were again shaken with sodium hydroxide and then with dilute sulphuric acid and finally washed several times with water. After drying with sodium sulphate and filtering, the ether was evaporated. The oily residue was of dark yellow color and it possessed a very penetrating, persistent and disgusting odor which resembled the natural odor peculiar to goats. In all, 45 liters of goat urine were distilled which yielded 22.3 grams of oil after distilling in vacuum at 1 mm. pressure.

The distillate was a light yellow oil of the same disgusting odor as the raw product. It was neutral to litmus and contained neither nitrogen nor sulphur. With concentrated nitric acid it reacted with great violence. Suspended in water it was immediately oxidized by potassium permanganate. It did not reduce Fehling's solution but an alkaline solution of silver nitrate was reduced on heating. In chloroform solution the substance takes up bromine with liberation of hydrobromic acid. The oil is easily soluble in all proportions in the ordinary organic solvents but insoluble in water or dilute alkali. When treated with concentrated alkali the disgusting odor disappeared and a pleasant terpene-like odor resulted.

On analysis the following result was obtained:

0.1537 gm. subst. gave 0.1078 gm. H_2O and 0.4350 gm. CO_2.

Found: $C = 77.19$; $H = 7.84$ per ct.

These figures agree with those found for the neutral oil from cow urine.[1] The composition is also identical with that of the substance called "Urogon" by Mooser.[2]

Since the oil had been extracted from a strongly alkaline liquid and as the ethereal solution had been further treated with sodium hydroxide it was thought that phenols had been completely removed. However, this was by no means the case as will be shown below.

The oil was further carefully fractionated in high vacuum at about 1 mm. pressure when the temperature rose slowly but continuously which indicated that the substance was not homo-

[1] See preceding article.

[2] W. Mooser. l. c.

geneous. After the greater portion had been distilled, the residue, a light yellow oil, was taken up in a little ether and shaken for a long time with 20 per ct. sodium hydroxide. The ethereal solution was washed with water, dried with sodium sulphate, filtered and the ether evaporated.

The oily residue was distilled and at 1 mm. pressure it went over between 101–102°. The distillate, which weighed 1.5 grams, was a light yellow colored oil of agreeable terpene-like odor and it appeared identical with the oil obtained from cow urine. It dissolved in concentrated sulphuric acid with a red color. It gave no reaction with concentrated nitric acid — on warming the acid the oil dissolved without any visible reaction and on diluting with water a cloudy solution resulted. It was insoluble in 20 per ct. sodium hydroxide or in 40 per ct. potassium hydroxide and on heating these solutions to boiling the oil turned brown in color. It did not crystallize or solidify on cooling in a freezing mixture to —20°. The aqueous suspension gave no color reaction with ferric chloride. Alkaline silver nitrate was reduced on heating and potassium permanganate was decolorized at room temperature.

The first, and principal, portion of the distillate mentioned above was treated with sodium hydroxide, 20 per ct., in the same manner and it yielded 0.9 gram of the non-phenolic oil boiling at 101–102° at 1 mm. pressure.

The alkaline solutions were reserved for further examination.

The non-phenolic oils were analyzed and the following results obtained:

FIRST PREPARATION.

0.1716 gm. subst. gave 0.1713 gm. H_2O and 0.4923 gm. CO_2.
Found: C = 78.24; H = 11.17 per ct.

SECOND PREPARATION.

0.1008 gm. subst. gave 0.1019 gm. H_2O and 0.2908 gm. CO_2.
Found: C = 78.68; H = 11.31 per ct.
For $C_{10}H_{16}O$ = 152. Calculated: C = 78.94; H = 10.52 per ct.

PREPARATION OF THE SEMICARBAZONE.

The oil, 1.1 grams, was dissolved in 13 c.c. of glacial acetic acid and to it was added a solution of 0.9 gram semicarbazide hydrochloride and 1.3 grams of sodium acetate in 2.5 c.c. of water. After standing for three or four days at room temperature, the perfectly clear solution was diluted with water and the oily substance which separated was extracted with ether. The ethereal solution was washed with dilute sodium hydroxide to remove acetic acid and then washed with water, and dried with sodium sulphate. After filtering, the ether was evaporated. The oily residue crystallized partially

on standing. To remove adhering oil the substance was spread upon a clay plate. The pure white crystalline substance which remained was twice recrystallized by dissolving in hot methyl alcohol and adding hot water until the solution turned cloudy. On cooling, the substance separated in colorless plates. The snow-white product finally obtained weighed 0.1 gram. The crystal form was identical with that of the semicarbazone obtained from the non-phenolic oil from cow urine and like the latter this substance also melted sharply at 165° (uncorrected). Since the crystal form and melting point of the two semicarbazones were exactly alike we believe that the substances were identical.

EXAMINATION OF THE ALKALI-SOLUBLE PORTION OF THE CRUDE NEUTRAL OIL.

The alkaline solution was acidified with sulphuric acid and the oil which separated was extracted with ether. The ethereal solution was dried with sodium sulphate, filtered and the ether distilled off. The oil which remained was distilled in vacuum and at about 1 mm. pressure it went over at 76°. It was obtained as a practically colorless oil of distinctly phenolic odor. It was completely soluble in 20 per ct. sodium hydroxide. It reacted with great violence with concentrated nitric acid. In concentrated sulphuric acid it dissolved with a faint red color. When cooled in a freezing mixture of ice and salt it crystallized to a white solid mass which again liquefied at room temperature. Its aqueous solution or suspension gave a fine blue color with ferric chloride. At atmospheric pressure the oil boiled at 198° (uncorrected).

The analysis gave the following result:

0.1042 gm. subst. gave 0.0744 gm. H_2O and 0.2949 gm. CO_2.
0.1696 gm. subst. gave 0.1172 gm. H_2O and 0.4816 gm. CO_2.
Found: $C = 77.18$; $H = 7.99$ per ct.
$C = 77.44$; $H = 7.55$ per ct.
For cresol, $C_7H_8O = 108$; calculated: $C = 77.77$; $H = 7.40$ per ct.

PREPARATION OF CRESOL URETHANE.

The cresol urethane was easily prepared according to the method of Snape[1] as follows: 1.08 grams of the substance analyzed above and 1.19 grams of phenylisocyanate were heated in a sealed tube for 16 hours in the steam bath. At the end of this time the content was still fluid but on shaking for a few minutes it crystallized, forming a solid mass. The substance was removed from the tube and washed several times with petroleum ether. It was then recrystallized by dissolving in 20 c.c. of hot alcohol and adding hot water until the solution turned cloudy. On scratching, the substance began to separate

[1] H. Lloyd Snape. *Ber. deut. chem. Ges.* 18:2429. 1885.

in large colorless plates. After standing in ice water for some time the crystals were filtered off and washed in dilute alcohol. The substance was again recrystallized from 10 c.c. of hot alcohol from which it separated, on cooling slowly, in long colorless needles or prisms. When the alcoholic solution is cooled quickly the substance separated in large colorless plates. The crystals were filtered and washed in a little ice-cold alcohol and allowed to dry in the air. Yield 0.9 grams. The balance of the substance can be obtained by adding water to the alcoholic solution.

When heated in a capillary tube the substance melted at 113° (uncorrected). According to Leuckart [1] as quoted in Beilstein the urethane of p-cresol melts at 114°.

After drying at 100° in vacuum over phosphorus pentoxide, when it did not lose in weight, the substance was analyzed.

0.1391 gm. subst. gave 0.0720 gm. H_2O and 0.3760 gm. CO_2.
For cresol urethane $CH_3 \cdot C_6H_4O \cdot CO \cdot NH \cdot C_6H_5 = 227$.
Calculated: $C = 74.01$; $H = 5.72$; $N = 6.16$ per ct.
Found: $C = 73.72$; $H = 5.79$ per ct.

PREPARATION OF THE DINITRO-CRESOL.

The oil itself, as has been mentioned previously, reacts with great violence with concentrated nitric acid. Sometimes long yellow needles separate when the reaction mixture cools but most frequently dark colored oily masses are obtained. However, the di-nitro derivative is easily obtained by the method mentioned in Beilstein. About 4 grams of the oil was dissolved in 4 c.c. of glacial acetic acid. To this solution was added slowly a mixture of 6 c.c. of concentrated nitric acid dissolved in 6 c.c. of glacial acetic acid. The vigorous reaction was soon completed and on standing a short time the nitro compound began to separate in long needles. After standing for two hours in the ice box the yellow crystals were filtered off and washed thoroughly in water. For recrystallization the substance was dissolved in a large quantity of boiling water (about 1.5 liters). The substance is very slightly soluble in water. At first it melts in the hot water and dissolves very slowly on continued boiling. After filtering and cooling slowly to room temperature long delicate golden yellow needles separated. These were filtered off, washed in water and dried over sulphuric acid in a vacuum desiccator.

The crystals melted when heated in a capillary tube at 83° (uncorrected). The 3.5 di-nitro p-cresol according to Beilstein melts at 85°.

The substance does not contain any water of crystallization as it does not lose in weight on drying over phosphorus pentoxide at the temperature of boiling chloroform.

[1] Leuckart. *Jour. prakt. Chem.* [2], 41:319.

From alcohol the substance crystallizes in very massive dark yellow needles which also melted at 83°.

On analysis the following result was obtained:

0.1718 gm. subst. gave 0.0509 gm. H_2O and 0.2678 gm. CO_2.

For di-nitro cresol, $CH_3 \cdot C_6H_2 (NO_2)_2 \cdot OH = 198$.

Calculated: $C = 42.42$; $H = 3.03$; $N = 14.14$ per ct.

Found: $C = 42.51$; $H = 3.31$ per ct.

For comparison with the above di-nitro cresol we prepared a di-nitro compound by the same method from the cresol isolated from cow urine. From the distillates from cow urine we had obtained about 300 grams of cresol as a by-product in the preparation of the non-phenolic volatile oils previously described.[1] The two di-nitro derivatives were found to be identical in every respect. The di-nitro cresol from cow urine crystallized from alcohol in massive dark yellow needles which melted at 83° (uncorrected) and from water it separated in long delicate golden yellow needles which also melted at 83° (uncorrected).

The identity of the two substances was further confirmed by the analysis.

0.1177 gm. subst. gave 0.0339 gm. H_2O and 0.1817 gm. CO_2.

Found: $C = 42.10$; $H = 3.22$ per ct.

There appears to be no doubt from the work reported above that the alkali soluble portion of the crude oil obtained from goat urine was identical with the oil obtained under similar conditions from cow urine. The study of the substance itself and the derivatives mentioned above makes it evident that the oil is p-cresol. The substance is also identical with the phenol called "Urogol" by Mooser[2]. Since we have shown, however, that the above oil is identical with p-cresol it is evident that "Urogol" also is not isomeric but identical with p-cresol.

III. THE NON-PHENOLIC VOLATILE OILS OF HORSE AND HUMAN URINE.

INTRODUCTION.

It was reported by Städeler[3] that the distillates from acidified urines from horses and human beings contained certain alkali insoluble volatile oils similar to the oil obtained from cow urine. Other investigators have observed and confirmed this report of Städeler. Hoppe-Seyler[4] states that in horse urine there occurs in addition to phenols also volatile camphor-like substances and Baumann,[5] in his exhaustive

[1] R. J. Anderson. See preceding article.
[2] W. Mooser. l. c.
[3] G. Städeler. Ann. *Chem.* 77:17. 1851.
[4] Hoppe-Seyler. Handbuch d. physiol. u. pathol. chem. Analyse. 1875, p. 109
[5] E. Baumann. *Pflügers Arch. Physiol.* 13:285. 1876.

investigations concerning the conjugated sulphuric acids in urine observed a similar substance. This author states: "Destilliert man das durch Zersetzung einer grösseren Menge Pferdeharn erhaltene, auf dem Wasser meist schwimmende Oel mit Aetzkali, so erhält man im Destillat auf dem Wasser schwimmende gelbe oelige Tropfen die frei von phenolartige Körper sind. Dieselben besitzen einen eigentümlichen, an gewisse ätherische Oele erinnernden Geruch." Brieger [1] describes a similar oil obtained from human urine. This substance is described as a light yellow colored oil of pleasant peppermint-like odor. By cooling it neither solidified nor crystallized. It contained nitrogen. It gave red colorations with fuming nitric acid, concentrated sulphuric acid and with Millon's reagent. With concentrated hydrochloric acid it gave a fine red color which changed into blue and after a while into a dirty violet. Bromine water gave a resinous precipitate but the oil gave no color reaction with ferric chloride. Given to a rabbit it caused no visible disturbance.

It has been claimed by Fricke [2] that both horse and human urine contain the substance "Urogon" described by Mooser [3] as existing in cow urine. We [4] have shown, however, that the substance "Urogon" is not homogeneous but a mixture consisting of p-cresol and a non-phenolic oil having the composition $C_{10}H_{16}O$, our results confirming the opinion expressed by Neuberg and Czapski.[5]

Dehn and Hartman [6] have recently reported the discovery in human urine of a substance which they call "Urinod." This substance is supposed to be the cause of the characteristic odor of urine and it is described as possessing other remarkable properties. It reacted with concentrated nitric acid with explosive violence and when treated with fixed alkalis a terpene-like odor was produced. The substance combined with bromine with liberation of hydrobromic acid. It gave no definite compounds with semicarbazide or hydroxylamine hydrochlorides but a crystalline di-nitro derivative was obtained.

In the present investigation we have confined ourselves entirely to the non-phenolic or alkali-insoluble portion of the oils obtained on distilling acidified horse urine and human urine. In the preparation of the so called neutral or alkali-insoluble oils from the distillates of urine it is necessary to bear in mind that the distillates contain large quantities of phenols, principally p-cresol, and a very small percentage of really neutral or alkali-insoluble oils. We have previously referred to the difficulty of completely removing phenols

[1] L. Brieger. *Ztschr. physiol. Chem.* 4:204. 1880.
[2] Ernest Fricke. *Pflügers Arch. Physiol.* 156:225. 1914.
[3] W. Mooser. *Ztschr. physiol. Chem.* 63:155. 1909.
[4] R. J. Anderson. See two preceding papers.
[5] C. Neuberg u. L. Czapski. *Biochem. Ztschr.* 67:28. 1914.
[6] W. M. Dehn and F. A. Hartman. *Jour. Am. Chem. Soc.* 36:2136. 1914.

from an ethereal solution by shaking the latter with aqueous alkali [1] and Neuberg and Czapski [2] have shown that both phenol and cresol may be extracted by petroleum ether from a strongly alkaline solution. Various authors like Mooser,[3] Fricke [4] and Dehn and Hartman [5] apparently have not taken the importance of this matter into account and have failed to assure themselves that phenols and cresols had been completely removed from the so called neutral oils which they finally obtained and analyzed.

We cannot believe that the oil described under the name of "Urinod" by Dehn and Hartman (l. c.) is any more of a chemically homogeneous substance than the "Urogon" of Mooser and Fricke. The properties ascribed to "Urinod" are practically identical with those which we have observed in the case of all so called neutral oils obtained from cow and goat urines. The peculiar chemical reactivity of these oils, viz., the violent reaction with concentrated nitric acid and the absorption of bromine with liberation of hydrobromic acid is due to the cresol contained in such oils and we feel quite certain that the substance called "Urinod" must also have been largely contaminated with phenol or cresol since it would have been practically impossible, in accordance with our experience, completely to remove all of the phenols by the method employed by Dehn and Hartman.

The peculiar and disgusting odors possessed by all of the crude neutral oils obtained from urine distillates are apparently caused by very minute quantities of powerfully odorous substances. These odors moreover differ according to the kind of urine from which the oils are isolated. The oil from goat urine, for instance, has a powerful and disgusting odor of goats, that from cow urine smells like the odor peculiar to cow stables and the oil from human urine has a strong and persistent odor which is very similar to that of human urine. These odors are destroyed by nitric acid as stated by Dehn and Hartman and they are also immediately destroyed by concentrated alkali when brought into direct contact with the crude oils. We have noticed also that these odors are lost on repeated fractionation of the oils in high vacuum. For this reason we believe that these highly odoriferous substances are very volatile bodies which are merely dissolved in the crude oils. The crude oils like "Urogon" and "Urinod" contain therefore not less than three substances, viz.

I. Principally cresol.

II. A small percentage of alkali insoluble neutral oils which vary according to the terpene-like bodies contained in the food, and

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[1] R. J. Anderson. See preceding papers.
[2] C. Neuberg u. L. Czapski. l. c.
[3] W. Mooser. l. c.
[4] Ernest Fricke. l. c.
[5] W. M. Dehn and F. A. Hartman. l. c.

III. The disgusting odoriferous bodies.

The first two can be separated by means of sufficiently concentrated alkali which dissolves out the cresol leaving the alkali insoluble oil, but the odoriferous substances become destroyed by this treatment — because the residual insoluble oil possesses an agreeable terpene-like odor and the cresol isolated after acidifying the alkaline solution has a pure phenolic odor without any trace of the disgusting odor of the original substance.

It would be interesting to study further these odorous substances. Such studies, however, are very difficult because these substances are apparently present in exceedingly minute quantities. Although we have tried to obtain some knowledge concerning the nature of these odorous bodies we have been unable to secure any other evidence of their existence than the smell.

EXPERIMENTAL PART.

THE NON-PHENOLIC VOLATILE OIL FROM HORSE URINE.

About 67 liters of mixed horse urine were collected during the winter. The fresh urine was evaporated to about one-eighth of its volume, strongly acidified with sulphuric acid and distilled with steam until no more oil went over. The distillates were extracted with ether and the ethereal solution was repeatedly shaken with 20 per ct. sodium hydroxide and then with dilute sulphuric acid, finally washed with water and dried with sodium sulphate. After evaporating the ether the oily residue was distilled in vacuum. There were obtained two grams of a light yellow oil which in odor resembled the product previously isolated from cow urine, but it differed in composition by containing nearly 3 per ct. more hydrogen.

0.1353 gm. subst. gave 0.1251 gm. H_2O and 0.3831 gm. CO_2.

Found: $C = 77.22$; $H = 10.35$ per ct.

The substance reacted slightly with concentrated nitric acid which indicated traces of cresol.

The oil was, therefore, thoroughly shaken with 20 per ct. sodium hydroxide until a milky emulsion was formed. This was extracted with ether and after drying and evaporating the ether the residue was again distilled in vacuum. At about 1 mm. pressure it went over at 100°. It was a light yellow colored oil, of pleasant aromatic or terpene-like odor, which weighed 0.7 gram. It was free from nitrogen and sulphur.

The alkaline solution, after extracting the above alkali-insoluble oil, was acidified with sulphuric acid, the oily substance was extracted with ether and finally distilled in vacuum. The distillate went over at 76° and 2 mm. pressure. It was a practically colorless oil of distinct phenolic odor which, when suspended in water, gave a fine blue coloration with ferric chloride and it reacted with great violence

with concentrated nitric acid. There appears to be no doubt, therefore, that this substance was cresol.

This shows again how difficult it is to extract all of the phenols from an ethereal solution by aqueous alkali. Traces of cresol remained in this oil in spite of the fact that the ethereal solution had been repeatedly shaken thoroughly with 20 per ct. sodium hydroxide.

PROPERTIES OF THE ABOVE ALKALI-INSOLUBLE, OR NEUTRAL, OIL.

The aqueous suspension of the oil gives no color reaction with ferric chloride.

It does not solidify in a freezing mixture of ice and salt.

When mixed with cold concentrated nitric acid the oily globules assume a red color and on warming the oil dissolves giving a yellow solution which on dilution with water turns cloudy.

With cold concentrated hydrochloric acid no change takes place, but on heating the oil turns red in color.

In cold concentrated sulphuric acid the oil dissolves giving a dark red solution.

In chloroform solution bromine is absorbed with liberation of hydrobromic acid.

Potassium permanganate solution is immediately decolorized. Ammoniacal silver nitrate is reduced on heating. It is soluble in all proportions in the ordinary organic solvents but insoluble in alkali or water.

On analysis the following result was obtained:

0.1247 gm. subst. gave 0.1224 gm. H_2O and 0.3423 gm. CO_2.
Found: $C = 74.86$; $H = 10.98$ per ct.
The percentage composition agrees with the formula $C_7H_{12}O$.
Calculated for this: $C = 75.00$; $H = 10.71$ per ct.

THE NON-PHENOLIC OIL FROM HUMAN URINE.

The fresh urine which was acid in reaction was made slightly alkaline by adding sodium carbonate and then evaporated to about one-eighth of its volume. The residue was acidified with sulphuric acid, distilled with steam, the distillate extracted with ether and the ethereal solution shaken repeatedly with 20 per ct. sodium hydroxide and then with dilute sulphuric acid. In all 111 liters of urine were evaporated and distilled. A small amount of yellow colored oil remained on evaporating the ether. The oil possessed a strong and persistent odor of human urine and it reacted slightly with concentrated nitric acid. In order to remove phenols completely the oil was shaken for some time with 20 per ct. sodium hydroxide and distilled from the alkaline solution with steam. The distillate was extracted with ether, the latter dried with sodium sulphate, filtered and evaporated and the residue distilled in vacuum when about

0.15 gram of a light yellow oil was obtained. It did not contain nitrogen.

This oil had an agreeable terpene-like odor, the odor of urine of the original crude oil having been lost in the treatment with sodium hydroxide.

In other respects it gave exactly the same reactions as described for the oil isolated from horse urine and it had practically the same composition.

0.1005 gm. subst. gave 0.0909 gm. H_2O and 0.2777 gm. CO_2.
Found: $C = 75.36$; $H = 10.12$ per ct.

This substance differs in composition from the "Urinod" of Dehn and Hartman (l. c.) by containing about 2 per ct. more hydrogen. It also differs from the above product by giving no reaction with concentrated nitric acid. The violent reaction produced when "Urinod" was treated with concentrated nitric acid was undoubtedly due to the presence of phenols.

Unfortunately the quantity of neutral oil obtained from horse urine and from human urine was too small to permit of a more extensive investigation. Of all the urines examined that from human beings contained the smallest percentage of neutral oil. Städeler (l. c.) also reported that the amount of oil obtained from human urine was very slight.

As a result of our investigation of the neutral alkali-insoluble oils obtainable from the urine of different animals we have found only two different kinds of oil so far as composition is concerned as is shown in the résumé below.

Composition.	C	H	*Corresponding to the formula*
From cow urine....	78.25	10.84	$C_{10}H_{16}O$ Calc.: $C = 78.94$, $H = 10.52$.
	78.90	11.12	
	78.30	10.46	
	79.15	10.49	
From goat urine...	78.24	11.17	
	78.68	11.31	
From cow urine.....	74.77	10.61	$C_7H_{12}O$ Calc.: $C = 75.00$; $H = 10.71$.
From horse urine ...	74.86	10.98	
From human urine..	75.36	10.12	

In conclusion we venture to express the opinion that the kind of neutral alkali-insoluble oils excreted in the urine of different animals to a large extent will be found to depend upon the nature of the terpene-like bodies contained in the food and for this reason the nature of the oil will vary in accordance with season and the available food supply.

REPORT

OF THE

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(Connected with Grape Culture Investigations.)

TABLE OF CONTENTS.

I. Plant lice injurious to apple orchards. I. Studies on control of newly-hatched aphides.
II. The cabbage maggot: Its biology and control.
III. The leaf weevil.
IV. Miscellaneous notes on injurious insects.
V. Some insects attacking the pear, and their control.
VI. The cherry leaf-beetle.
VII. Periodical cicada in 1916.

[1] Absent on leave from June 1, 1915, to September 15, 1916.
[2] Appointed June 15, 1915; resigned September 15, 1916.

REPORT OF THE DEPARTMENT OF ENTOMOLOGY.

PLANT LICE INJURIOUS TO APPLE ORCHARDS. I.*

STUDIES ON CONTROL OF NEWLY-HATCHED APHIDES.

P. J. PARROTT, H. E. HODGKISS, AND F. H. LATHROP.

SUMMARY.

The studies reported in this text deal with certain habits of the rosy apple aphis (*Aphis sorbi* Kalt.), the oat aphis (*Aphis avenæ* Fab.) and the green apple aphis (*Aphis pomi* DeGeer), and with experiments to determine their relative susceptibilities to spraying mixtures.

These aphides attack succulent tissues, as the stems of unopened blossoms and tender fruits and young leaves, and derive subsistence from such structures. During 1915 the dwarfing and deforming of apples were largely if not entirely the work of the rosy aphis. The effects of the oat aphis and the green apple aphis on the setting and development of fruit were not clearly indicated, but present evidence suggests that when numerous they may cause harm to blossom clusters and retard growth of young apples. The first external evidence of attack by the rosy aphis on the fruit was a retardation of increase in transverse diameter of the apples. Continued infestation resulted in a considerable reduction of both the transverse and axillary diameters. The extent of injury largely varied with the degree of infestation, while the rate of development of the apples was in inverse ratio to the numbers of the insects. The average of the calibrations of infested apples was 1.51 ins. for axillary diameter and 1.71 ins. for the transverse diameter. The checks measured 2.37 and 2.87 ins. respectively. In addition to inhibition of growth, attacks on the fruit by the insects produced various distortions of the apples.

Against the rosy aphis, spraying when buds were opening in an apple orchard (variety Rome) gave the following results: Average per sprayed tree, 2.55 centers of infestation, 1.83 injured fruits and 9.55 curled leaves; average per unsprayed tree, 45.71 centers of

* A reprint of Bulletin No. 415, February, 1916.

infestation, 39.85 injured fruits and 189 curled leaves. Other experiments gave somewhat similar data. This treatment completely destroyed the oat aphis and afforded the trees temporary relief from the green apple aphis. These results in the main point to the spraying of apple trees as buds are breaking as the important initial step in the prevention of injuries.

Nicotine solution and soap, nicotine solution and lime-sulphur, and crude carbolic acid emulsion proved to be efficient insecticides, usually killing a large percentage of the insects wetted by them. In one comparative experiment against the rosy aphis there were indications of somewhat greater efficiency for nicotine solution and soap and nicotine solution and lime-sulphur. Of the foregoing preparations nicotine solution and soap proved uninjurious to foliage, while nicotine solution and lime-sulphur, and crude carbolic acid emulsion caused slight but unimportant injuries to apple leaves. Sodium sulphide and soap in combination, while an efficient aphidicide, caused serious injuries to opening buds and tender leaves.

The continued multiplication of the green apple aphis and constant production of winged forms necessitated repeated applications to obtain entire immunity of apple trees from this species. Experiments with soap and nicotine solution showed that while these are efficient sprays as contact insecticides, they afford only temporary protection. The value of nicotine solution was enhanced by the addition of large amounts of lime. In tests with this and other species of plant lice that are monophagous and breed for a long period on the same host, the need of spraying mixtures with more lasting toxic or repellent properties was strongly indicated.

INTRODUCTION.

Notwithstanding the admitted belief that the insects are susceptible to various remedial measures, there is no extensive body of positive and proven evidence which shows what can actually be accomplished in a practical way towards the prevention of losses by the various species of aphides that are injurious to foliage and fruit in bearing apple orchards. It therefore seems worth while to direct attention to certain studies on the activities of the creatures and to experimental results which bear on the susceptibility of these aphides to spraying mixtures. The matter is an important one because of the increasing shrinkages in apple yields in conse-

quence of the injurious work of these pests and the extreme difficulty of controlling the aphides by the measures usually advocated, some of which are strikingly at variance with experience and practice.

In order to secure data applicable to New York conditions this Station has been and is conducting a series of spraying experiments against the insects in apple orchards in the western portion of the State. The work so far points to the destruction of the aphides on the expanding buds as the most important step to avoid injuries by these pests. From a practical, as well as a scientific standpoint, this method of control requires additional study and experimental effort to develop greater efficiency in spraying practices. For this reason it has seemed important to those who have had the planning of these experiments that they continue over a series of years in order to eliminate as far as possible inaccuracies due to unknown and uncontrollable conditions and thus secure accuracy of results from which conclusions may be drawn. The chief purpose of this bulletin, which is our second report in this study, is to contribute further data on the habits of the insects, the susceptibility of the newly-hatched aphides to various insecticides and the effects of spraying when buds are breaking in reducing injuries to the apple crop. The data are presented under the following headings:

1. Seasonal behavior of the aphides injurious to apple foliage and fruit.
2. Influence of aphides on growth of apples.
3. Test with lime-sulphur and nicotine solution on Rome apples.
4. Test of various insecticides on mixed varieties of apples.
5. Test on young apple trees against the green apple aphis.
6. Auxiliary experiments.

OBSERVATIONS AND EXPERIMENTS.

SEASONAL BEHAVIOR OF THE APHIDES INJURIOUS TO APPLE FOLIAGE AND FRUIT.

Injuries to the foliage and fruit of bearing apple orchards in western New York were not as much in evidence during the summer of 1915 as in the preceding year. The important fruit-growing counties of Niagara and Orleans suffered very little from the insects, especially the rosy aphis. In occasional orchards about Spencerport, Wolcott, Geneva and other localities there was considerable evidence

of the destructive work of these pests, and quite similar conditions prevailed generally in such counties as Monroe, Wayne, Ontario and Oswego.

The more important facts in the seasonal development of the different species are briefly indicated as follows:

Rosy apple aphis.—Hatching of this species (*Aphis sorbi* Kalt.) occurred during the period of the swelling and breaking of the buds, and, as indicated by certain experiments, all of the nymphs had probably emerged from the eggs by April 24, at which time the tips of the leaves were beginning to project from the ends of buds in the most advanced stages of growth. On May 3, at which time most varieties of apples showed pink in the blossoms, many of the stem-mothers were giving birth to young. The creatures occupied exposed positions on stems of the blossoms, which were as yet unopened, or on the under surfaces of the leaves. The foliage at this date was little affected and only an occasional leaf showed evidence of being curled or rolled by the insects. As will later be observed, the oat aphis was much more numerous during this period because of the early maturing of the stem-mothers and the rapid rate of reproduction, which was now at its height. Frequently single specimens of *sorbi* could be found intermixed with large numbers of *avenæ* about blossom stems or in curled leaves. For a period about May 7 there was an actual reduction in the numbers of the stem-mothers of the rosy aphis. The diminution was attributed to the attacks of its parasitic and predaceous enemies which were abundant and undoubtedly destroyed many of the plant lice. On May 12 when trees were coming into full blossom there was a noticeable increase of the rosy aphis, coincidental with the maturing of the first individuals of the second generation, which were about to produce offspring. As late as May 23, however, solitary stem-mothers or stem-mothers with from eight to fifty-two offspring about them were observed at Geneva. Six days later similar conditions prevailed at Wolcott, where single stem-mothers were detected surrounded with from ten to thirty-five young. At this latter date, as the calyx cups of young apples were closing (Plate XXXI), there began a period of activity by the insects which was characterized by a greatly accelerated rate of reproduction. For the succeeding two weeks the insects spread from the few isolated leaves, which constituted the initial centers of infestation, to the remaining leaves

of the affected clusters, and from them to the unfolding leaves of adjacent new growth. During a period of a few days of high temperatures and great humidity about June 15, while apples were about the size of marbles, the rosy aphis multiplied with still greater rapidity. In the suddenness of the attack and the overwhelming invasion of the new terminal growth, watersprouts, and fruit and leaf clusters, as evidenced by the curling and discoloration of the affected leaves, the effect was strikingly similar to that of a virulent attack by a blighting disease. An interesting fact to be noted in this production and spread of the rosy aphis was the complete infestation of the new growth of leaf-clusters, tips of young shoots and water-sprouts on trees or portions of trees where heretofore there had been little or no indication of the presence of the pest. On June 18, at which time the young apples ranged in size from marbles to small walnuts, the stunting and deforming effects of the attacks upon the fruit were plainly evident on trees in the Station orchards. At Wolcott the stunting of young apples was first detected on June 8.

As to the winged forms, occasional specimens were first observed at Geneva on June 8 and at Wolcott on June 12, and during the following week the creatures were detected on the narrow-leaf plantain (*P. lanceolata* L.). By June 22 large numbers were developing wings, and whole leaf and fruit clusters once infested by them were now free of the insects. On the other hand, larger or smaller numbers of wingless aphides were observed, and in some instances fruits the size of walnuts were much infested on one side by them.

Oat aphis.— At Geneva the oat aphis (*Aphis avenæ* Fab.) began to hatch on April 16. At this time many buds showed very little separation of the bud scales, and only an occasional bud, usually at the end of the terminal growth, exhibited any evidence of green tissues. As shown by a number of spraying experiments, hatching of this species, as well as of the rosy aphis, was completed as the buds showed green tissues (Plate XXXVI). Antedating the rosy aphis by about seven days, specimens of *avenæ* were mature by April 26 and were then giving birth to young. On May 3 when apple blossoms were showing pink and hardly ready to open, blossom clusters generally were infested with the insects, which ranged as high as thirty to forty individuals to a bud. On an average there were three or four stem-mothers to thirty or forty of their offspring. From the

leaves, sepals and stems of the unopened blossoms sap was oozing in globules from the feeding punctures of the insects, and in some instances it appeared that the insects were causing the surfaces of the stems to be roughened or pimply. Not infrequently as many as eighteen to thirty-four aphides were also observed on a single petal and where the insects were numerous the leaves at this date were beginning to curl. In comparison with this species, *sorbi* at this date was quite scarce and was represented entirely by solitary stem-mothers or stem-mothers surrounded by a few of their offspring. On May 12 winged forms of the oat aphis were detected, and by May 20, when the petals were dropping, many of the creatures were in the winged state. Four days later the numbers of the species were greatly reduced by the migration of the winged forms to their summer host plants. On May 29, when the petals had dropped, apple trees about Geneva were practically free from this species.

Green apple aphis.— At Geneva this species (*Aphis pomi* DeGeer) hatched during the period of April 16 to 24. Stem-mothers began to mature about May 4, when pink of the apple blossoms was showing, and on this date a few specimens were observed with small numbers of offspring about them. On May 15, or about eleven days after birth, winged forms of this generation appeared. At Wolcott on May 23 great numbers of wingless and winged forms of this species were observed in the blossom and leaf clusters in a commercial plantation of Gilliflower apples, causing destruction of blossoms and severe injury to foliage. About Geneva this species was present in great numbers on the terminal growth of nursery stock and of young apple trees that were from two to five years old from planting. On the whole this species caused little foliage injury during the earlier part of the summer as there seemed to be a tendency for the creatures to ascend the growing shoots and attack the tender leaves as they unfolded. In abandoning the lower leaves for the newer ones the insects appeared not to be established a sufficient time on any of the foliage to cause much damage, aside from a slight incurving of the margins of the leaves. Towards the latter part of the summer the terminal portions of the new growth seemed less able to withstand the attacks of the pests, and during early August there were marked evidences of damage. The foliage of badly-infested trees at this time was frequently much curled and often blackened with the sooty fungus (Plate XXXIV). In extreme cases leaves become discolored

and dropped and in not a few instances a goodly portion of the shoots, commencing from the tips, were killed.

An interesting fact in connection with this species is that on June 22 and for several succeeding days there was a distinct flight of winged individuals. These came from some unknown source and swarmed over small and large apple trees alike in the region of Geneva, establishing themselves on the undersides of the upper leaves of the new growth.

From our observations of the insects on bearing trees it is apparent that the three species prefer succulent tissues, as the stems of unopened blossoms, stems of tender fruits and young leaves; and they derive subsistence from all such structures. Dwarfing and deforming of apples were mainly, if not entirely, the work of *sorbi*, and became apparent soon after blossoms dropped from the trees. The effects of *avenæ* and *pomi* on the setting of the crop and the development of the fruit were not so clearly indicated. When numerous each species is apparently capable of causing harm to blossom clusters, even before the opening of blossoms, and probably inflicts some damage on young apples. Present evidence points to the conclusion that injuries by the different species are cumulative, increasing day by day and week by week, and that damages by one species may be intensified by the succeeding species as conditions favor their development to destructive numbers.

INFLUENCE OF APHIDES ON GROWTH OF APPLES.

In order to measure the influence of the rosy aphis on the growth of apples, twenty infested fruit clusters and an equal number of uninfested clusters were selected on a Rome apple tree. The infested clusters contained sixty-one apples, giving an average of 3.05 fruits to a cluster, while the uninfested ones bore fifty-four apples, making an average of 2.7 fruits to a cluster. The selections were made from all sides of the tree, the infested and free clusters being so interspersed that, so far as could be observed, they were, with the exception of one factor — infestation by the rosy aphis — affected by similar conditions.

The infested clusters were divided into three lots according to the numbers of aphides on them as follows: Series I, four clusters severely infested with aphides; Series II, eleven clusters moderately infested; and Series III, five clusters slightly infested. The checks, Series IV, comprised twenty fruit clusters, the apples of which were normal in all respects and not different from the general run of the sound fruit on the tree. During the summer all the apples were

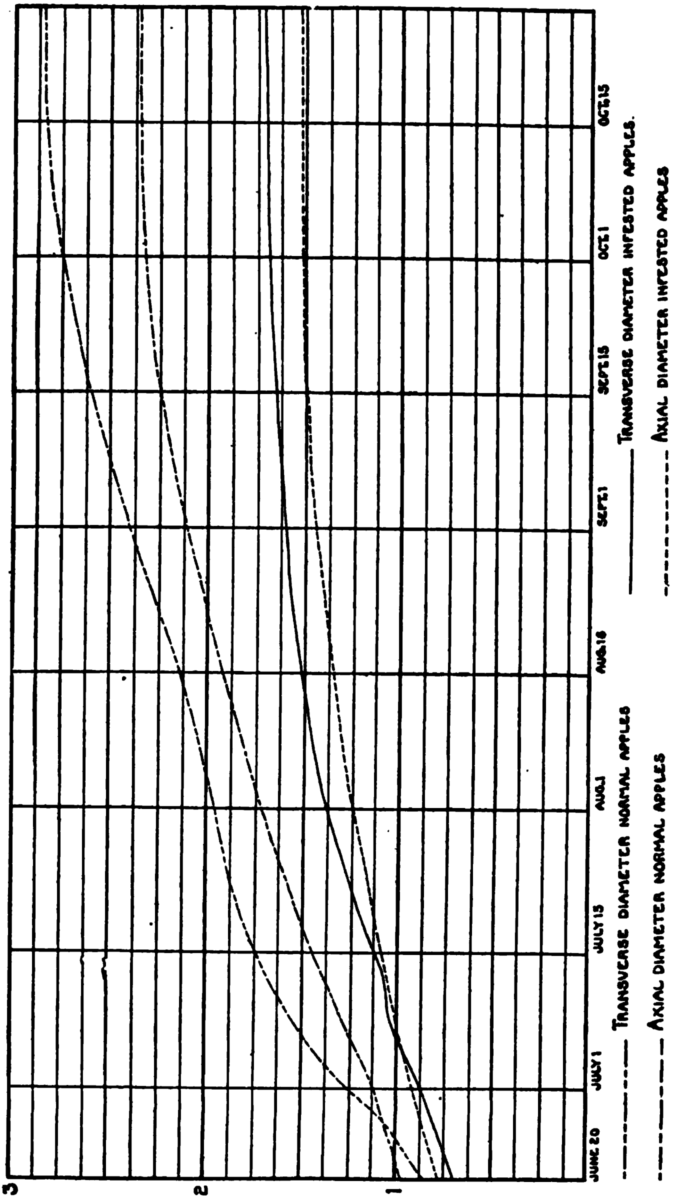

FIG. 6.—DIAGRAM SHOWING GROWTH OF APPLES INFESTED WITH ROSY APHIS IN COMPARISON WITH NORMAL FRUIT.

calibrated at rather frequent intervals, the measurements being taken on June 20, 24 and 28; July 6, 10, 16, 23 and 30; August 11 and 18; September 8 and 25; and October 1, 8 and 18. The crop was harvested at the last-mentioned date.

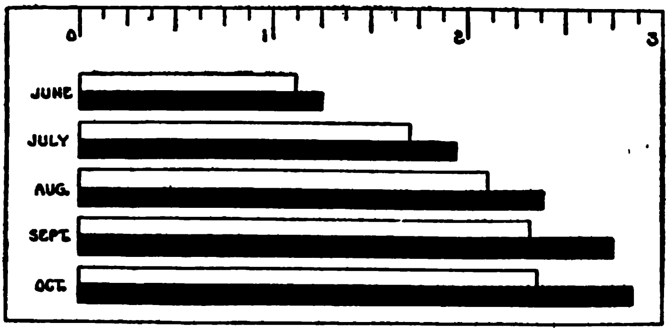

FIG. 7.—DIAGRAM SHOWING AVERAGES OF MEASUREMENTS OF NORMAL APPLES DURING SUMMER OF 1915.
White bars, axillary diameter; *black bars*, transverse diameter.

As previously noted, the calyx cups of apples about Geneva began to close on May 29, and during the following weeks the rosy aphis multiplied very rapidly. This increase in the numbers of the insects was attended by injuries to young apples, which were externally

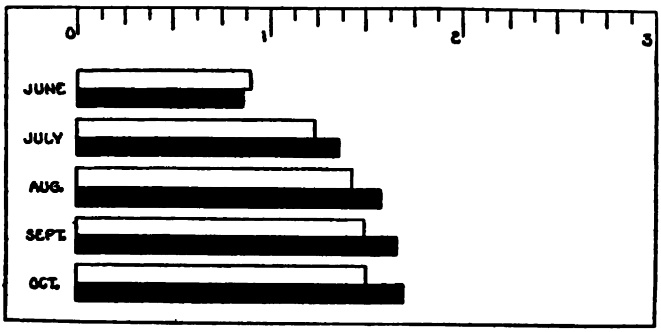

FIG. 8.—DIAGRAM SHOWING AVERAGES OF MEASUREMENTS OF APPLES INFESTED WITH ROSY APHIS.
White bars, axillary diameter; *black bars*, transverse diameter.

apparent during the first and second weeks in June. The effect of the attack was to cause a dwarfing of the young fruit, which was first indicated by a marked retardation of increase in transverse diameter. Affected apples therefore at this period appear to be

proportionately longer than the normal fruit. The average measurements, at intervals as stated, of the axillary and transverse diameters are given in Fig. 6. A study of the curves shows that while with apples in the early stages of development the axillary diameters of all series exceed the transverse diameters, the transverse diameters of the normal fruit increased much more rapidly than those of the affected fruit. The transverse diameters of the sound series equaled the axillary diameters on June 28, and rapidly exceeded them thereafter. The transverse diameters of infested apples, however, did not equal the axillary diameters until July 4, and the measurements subsequently until July 15 closely approximated each other. The inhibition of growth by the aphides is graphically shown in Figs. 7 and 8. The white bars represent the average of the measurements of the axillary diameters of the apples, while the black bars represent similarly the transverse diameters. Fig. 7 gives the average measurements of all of the fruit of the sound clusters, while Fig. 8 shows the average measurements of all of the fruits of the infested clusters. The average rate of growth of the apples in the two lots is shown in Table I.

TABLE I.—AVERAGE GROWTH OF SOUND APPLES AND APPLES INFESTED WITH ROSY APHIS.

SOUND APPLES.			INFESTED APPLES.		
	Axillary diameter.	Transverse diameter.		Axillary diameter.	Transverse diameter.
	Ins.	*Ins.*		*Ins.*	*Ins.*
June	1.125	1.265	June	0.906	0.875
July	.593	.688	July	.344	.500
August	.407	.453	August	.187	.218
September	.218	.359	September	.063	.094
October	.032	.110	October	.015	.031
Totals	2.375	2.875		1.515	1.718

It will be observed that the greatest development of the fruit occurred in June, the growth being less rapid as the season advanced. As previously indicated, the apples of the infested series sustained a great check to their development during early June, although the destructive work of the pest apparently continued in some cases until the middle of July. In this connection mention should be

made of the fact that June 14 marked the beginning of the period when fruit and leaf clusters were being entirely abandoned by the rosy aphis, and all those considered in the foregoing series were

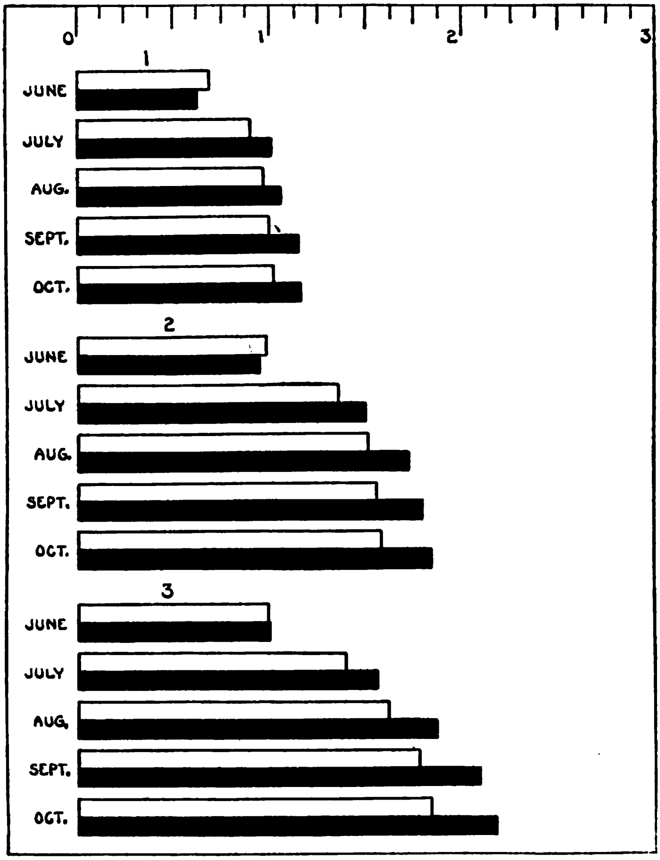

FIG. 9.—DIAGRAM SHOWING VARIATIONS IN SIZES OF APPLES ACCORDING TO DEGREE OF INFESTATION.

White bars, axillary diameter; *black bars*, transverse diameter. (1), Apple cluster severely infested; (2), apple cluster moderately infested; (3), apple cluster slightly infested.

free of the insects by July 6. Efforts to establish the aphides on apples met with failures after June 23, while some fruit clusters near those that were calibrated continued to be infested until July 15.

The inhibition of the growth of the young apples varied largely according to the extent of infestation. In general the rate of development was in inverse proportion to the degree of infestation—the larger the number of aphides the smaller the size of the affected fruit. The extent of this variation according to the degree of infestation is represented graphically in Fig. 9, which is based on the measurements of three typical clusters. At the time of harvesting, October 18, there were forty-nine apples of the infested series I, II, and III, and thirty-one apples of the checks or series IV. When picked the fruit was classified according to size as follows:

LOT I. INFESTED APPLES.

5 apples less than 1 inch in diameter.
8 apples between 1 and 1 1/2 inches in diameter.
9 apples between 1 1/2 and 1 3/4 inches in diameter.
14 apples between 1 3/4 and 2 inches in diameter.
8 apples between 2 and 2 1/4 inches in diameter.
5 apples between 2 1/4 and 2 1/2 inches in diameter.

LOT II. CHECK OR SOUND APPLES.

7 apples between 2 1/4 and 2 1/2 inches in diameter.
10 apples between 2 1/2 and 2 3/4 inches in diameter.
6 apples between 2 3/4 and 3 inches in diameter.
7 apples between 3 and 3 1/4 inches in diameter.
1 apple 3 3/8 inches in diameter.

Because of irregular shape, only two of the infested apples of marketable size in Lot I were of commercial value, and with these exceptions all of the fruits in this class were practically worthless. Aside from indicating the variation in extent of injury, these figures show more clearly, perhaps, than any other statistical data that have been given, the destructive power of the rosy aphis and the character of the shrinkages in fruit yields following a severe attack.

Reduction in the size of the fruits is not the sole injury sustained by young apples by attacks of aphides. There is in addition a distortion of their shape, which consists in the flattening of the calyx area or of the protrusion of the calyx or the checking of the growth of the fruit on one side (Plate XXXIII). These disfigurements are of varying intensity; sometimes so slight as to be scarcely noticeable, and in extreme cases so severe that the apples are knotty and gnarly

and generally misshapen. In the series under observation the apples were always distorted when both leaves and fruit of a cluster were affected, but such malformations were little in evidence when the infestation by insects was entirely restricted to the foliage of a fruit cluster. In the latter case the leaves were generally curled, and while the fruit, as will be later shown, was more or less reduced in size, there was no visible distortion of the apples aside from a slight flattening of the calyx area in some instances.

Another characteristic result of infestation by the rosy aphis was the failure of many of the apples to drop, with the result that the dwarfed, deformed fruit hung in clusters. In the different series under observation the average number of apples on the infested

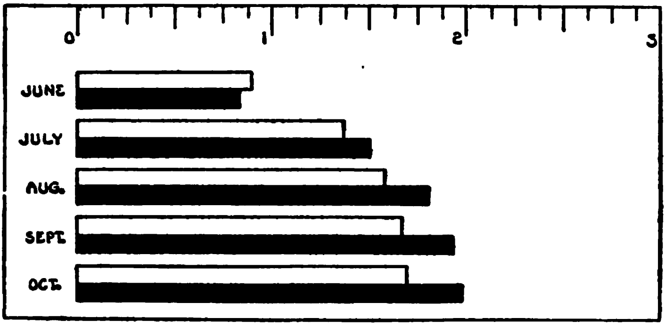

FIG. 10.—DIAGRAM SHOWING INFLUENCE OF LEAF INFESTATION ON GROWTH OF APPLES.
White bars, axillary diameter; *black bars*, transverse diameter.

clusters was greater than that of the normal clusters. At the time when the first measurements were made the largest number of apples on an affected cluster was seven, while the largest number of apples on a sound cluster was five. At the end of the season the largest numbers per cluster were respectively six and five apples. The average number of apples per cluster at the beginning of the period, as stated previously, was 3.05 fruits for the affected clusters and 2.7 fruits for the sound clusters. The average number of apples per cluster at the conclusion of the period of observation was respectively 2.63 fruits for the infested clusters and 1.83 fruits for the sound clusters.

Besides the injuries that result from the direct attack of the rosy aphis upon the apples, there are also damages to the crop in consequence of infestation of adjoining leaves. As a rule infestation of the

fruit is accompanied by the presence of more or less of the insects on the foliage, and generally the first intimation of an attack is the curling of one or more of the adjacent leaves. The question arises as to the extent of influence of the insects on the size of the apples when the infestation is confined solely to the foliage. To obtain data on this point calibrations were made of thirteen apples, distributed among five clusters, the leaves only of which were infested with the rosy aphis. The average measurements of these apples are shown in Fig. 10. It will be observed that these are intermediate in size between those obtained from normal fruit and those from apples directly attacked by the insects, as shown in Figs. 7 and 8. These apples, while undersized and unfit for the market, lacked the distortions so characteristic of fruits that had been infested by goodly numbers of aphides.

TEST WITH LIME-SULPHUR AND NICOTINE SOLUTION ON ROME APPLES.

This experiment was undertaken to get more detailed data than heretofore obtained in our work as to the effects upon the different species of aphides of spraying when buds are breaking, and the extent of protection to foliage and blossom and fruit clusters afforded by the treatment. The orchard chosen for the test consists of sixty trees of the variety Rome for the permanent planting. This variety was top-worked on Ben Davis, the Rome buds all having come from one tree and the stock having been carefully selected. This precaution was taken to exclude individual variations. The trees were set, forty feet apart, in 1896 and are therefore about nineteen years old (Plate XXXV). Provision for ample pollination is provided by intervening rows of apple trees, embracing approximately one hundred seventeen other varieties. The whole orchard has been given careful attention with respect to cultivation, pruning, spraying, etc. During 1909, 1910 and 1914 the trees of the variety Rome sustained severe injuries by plant lice, especially the rosy aphis.

DETAILS OF EXPERIMENTAL OPERATIONS.

In this test the entire orchard was sprayed with lime-sulphur and nicotine solution. Lime sulphur testing 32° B. was used in the proportions of one gallon to eight gallons of water in order to combat the San José scale, and to every one hundred gallons of the dilute mixture there was added three-fourths of a pint of nicotine solution

(40 per ct.) to destroy the plant lice. The trees were divided into three plats, which were sprayed on April 24, 26 and 27, respectively, in order to catch the insects as the buds were in different stages of development. The applications were made with a power-sprayer under rather high pressures, using "mistry" nozzles with coarse

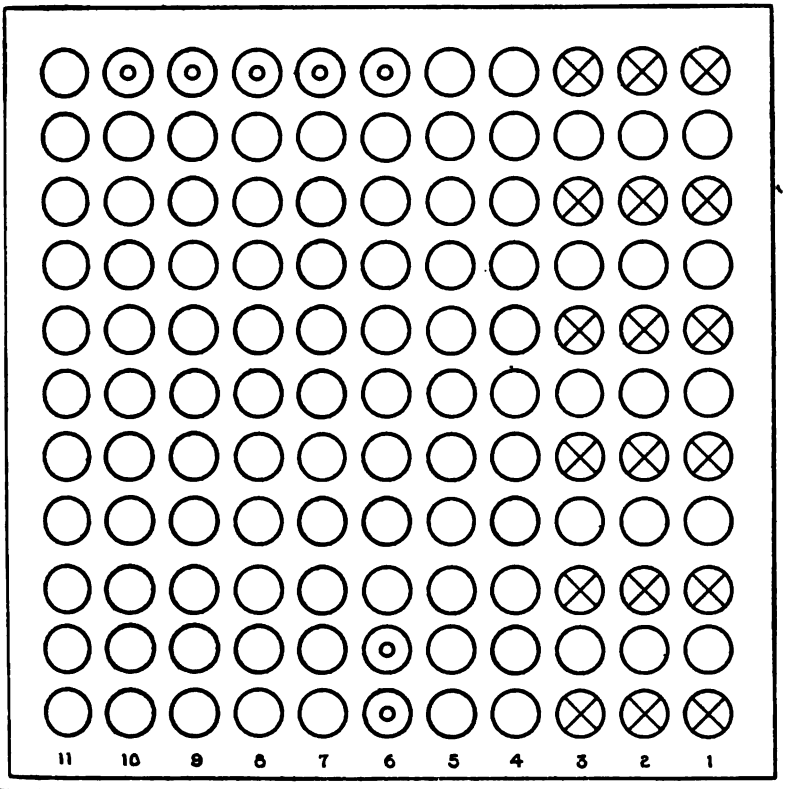

FIG. 11.—DIAGRAM OF ROME BEAUTY ORCHARD SHOWING SPRAYED PLAT AND CHECK TREES.

X, Sprayed trees; O, Checks.

apertures. The men operating them were cautioned to spray carefully in order to thoroughly wet the ends of all the buds, and to this end to apply the spraying mixture in liberal amounts. This experiment deals with three rows of the Rome apple, with the interplantings, sprayed on April 24 when the buds were green at the ends, and in some instances the tips of young leaves were projecting from the

buds (Plate XXXVI). The plan of the orchard showing the location of the sprayed trees and the checks is given in Fig. 11. For the checks there were seven Rome trees. The number of trees sprayed in this plat were eighteen Rome and thirty-two trees of the same age of other varieties. For the treatment of these trees five hundred gallons of spraying mixture were applied, making an average of ten gallons per tree.

RESULTS OF SPRAYING ON APHIDES AND TREES.

At the time of treatment the oat aphis was abundant on all of the trees, scarcely a bud being free from the insects. The effect of the spraying was most marked. Following the application there was an almost complete disappearance of the creatures, and it was difficult to find a single specimen for the remainder of the period when one would normally find the species on apple trees. With the checks, quite different conditions prevailed. At first there was a gradual increase in the numbers of the aphides when, during the period of May 3 to May 12, the blossom clusters particularly were generally overrun with them. Many insects were clustered about the basal portions of the stems, from which there exuded tiny globules as a result of the feeding punctures of the insects. At this time stems of blossoms were observed that presented a roughened or " pimply " appearance. In addition more or less of the lice were assembled on the petals of the unopened blossoms and on the leaves, which were slightly curled or presented a wrinkled appearance.

The rosy aphis was not present in great numbers on the trees during the season. Until June 15 not an individual of this species was observed on any of the sprayed trees, then one small colony was observed on Tree 9, Row 1. A little later slight infestations were noted on a few more trees. While the checks were not abundantly infested, it was not difficult during early May to find stem-mothers. The trees gradually presented less satisfactory conditions as the season advanced, and by June 8 the aphides became numerous enough to cause appreciable damage to both fruit and leaf clusters. On June 27 when the principal injury had been done by the insects and they had practically disappeared from the orchard, each Rome tree and some of other varieties in the sprayed and unsprayed plats were carefully examined to note conditions with respect to injury by the rosy aphis. The data are collected in Table II.

TABLE II.— RESULTS OF SPRAYING AGAINST ROSY APHIS.

Variety.	Row and tree.	Treatment.	Conditions with Respect to Injuries. Fruit clusters affected.	Terminal shoots affected.	Leaf clusters affected.	Water sprouts affected.	Total centers of infestation.	Fruits injured.	Leaves curled.
	No.						No.	No.	No.
Rome	Row 1, tree 1	Lime-sulphur and nicotine	0	4	0	0	4	0	7
Rome	" 1, " 3	" " " "	0	0	0	0	0	0	0
Rome	" 1, " 5	" " " "	0	3	0	0	3	0	23
Rome	" 1, " 7	" " " "	0	0	0	0	0	0	0
Rome	" 1, " 9	" " " "	10	10	3	0	23	26	70
Rome	" 1, " 11	" " " "	0	0	0	0	0	0	0
Husband	" 1, " 2	" " " "	0	0	0	0	0	0	0
Axident	" 1, " 4	" " " "	0	0	0	0	0	0	0
Hanlon	" 1, " 6	" " " "	0	1	7	0	8	0	29
Rome	" 2, " 1	" " " "	0	0	0	0	0	0	0
Rome	" 2, " 3	" " " "	0	0	0	0	0	0	0
Rome	" 2, " 5	" " " "	0	1	0	0	1	0	6
Rome	" 2, " 7	" " " "	0	5	0	2	7	0	34
Rome	" 2, " 9	" " " "	0	0	0	0	0	0	0
Rome	" 2, " 11	" " " "	0	0	0	0	0	0	0
Hyslop	" 2, " 2	" " " "	0	0	0	0	0	0	0
Florence	" 2, " 4	" " " "	0	0	0	0	0	0	0
Wagener	" 2, " 8	" " " "	0	0	0	0	0	0	0
Kinnard	" 2, " 10	" " " "	0	0	0	0	0	0	0
Rome	" 3, " 1	" " " "	0	0	0	0	0	0	0
Rome	" 3, " 3	" " " "	0	0	0	0	0	0	0
Rome	" 3, " 5	" " " "	1	0	0	0	1	4	5
Rome	" 3, " 7	" " " "	0	3	0	0	3	0	11
Rome	" 3, " 9	" " " "	0	0	0	0	0	0	0

TABLE II.—RESULTS OF SPRAYING AGAINST ROSY APHIS (*concluded*).

VARIETY.	Row and tree.	Treatment.	Conditions with Respect to Injuries.				Total centers of infestation.	Fruits injured.	Leaves curled.
			Fruit clusters affected.	Terminal shoots affected.	Leaf clusters affected.	Water sprouts affected.			
	No.						*No.*	*No.*	*No.*
Rome	Row 3, tree 11	Lime-sulphur and nicotine	1	3	0	0	4	3	16
Kinnard	" 3, " 2	" " " "	0	0	0	0	0	0	0
Hubbardston	" 3, " 6	" " " "	0	0	0	0	0	0	0
Wagener	" 3, " 8	" " " "	0	0	0	0	0	0	0
Rome	" 6, " 1	Check	29	42	21	0	92	73	413
Rome	" 6, " 2	"	9	9	4	0	22	11	51
Rome	" 7, " 11	"	18	51	25	0	94	72	469
Rome	" 8, " 11	"	15	19	4	0	38	21	112
Rome	" 9, " 11	"	11	15	0	0	26	23	104
Rome	" 10, " 11	"	9	3	1	1	14	26	46
Rome	" 11, " 11	"	20	8	3	2	33	53	128
Collins	" 12, " 11	"	3	0	9	7	19	11	62

TABLE III.— SUMMARY OF EXPERIMENT AGAINST ROSY APHIS.

NUMBER AND VARIETY OF TREES.	Treatment.	Centers of infestation.	Fruits injured.	Leaves curled.
		No.	*No.*	*No.*
18 Rome	Sprayed	46	33	172
10 Mixed varieties	Sprayed	8	0	29
7 Rome	Not sprayed	319	279	1,323
Average per sprayed tree, Rome		2.55	1.83	9.55
Average for all sprayed trees		1.93	1.17	7.17
Average per unsprayed tree, Rome		45.57	39.85	189

DISCUSSION OF RESULTS.

There are two facts which the data in this experiment bring out clearly. The one of greatest interest and importance is that the oat aphis and rosy aphis had largely, if not entirely, hatched when the buds were still compact and the tips of the leaves were barely showing. The other fact, which is strongly indicated, is that the destruction of the newly-hatched aphides by the treatment afforded a large degree of protection to both fruit and foliage.

TEST OF VARIOUS INSECTICIDES ON MIXED VARIETIES OF APPLES.

The purpose of this experiment was to determine the merits of various insecticides for the control of the aphides as well as to ascertain the effects of bud treatment upon these insects in an orchard of mixed varieties of apples. The spraying mixtures tested were lime-sulphur with nicotine solution, soap with nicotine solution, sodium sulphide with soap, and crude carbolic-acid emulsion. The formulas for the different spraying mixtures are as follows:

(1) Lime-sulphur and nicotine solution:
- Lime-sulphur solution (32° B.) .... 11 gals.
- Nicotine solution (40 per ct.) .... ¾ pint.
- Water .... 89 gals.

(2) Soap and nicotine solution:
- Soap .... 5 lbs.
- Nicotine solution (40 per ct.) .... ¾ pint.
- Water .... 100 gals.

(3) Sodium sulphide and soap:
- Sodium sulphide (56 per ct. sul.) .... 15 lbs.
- Soap .... 5 lbs.
- Water .... 50 gals.

(4) Crude carbolic-acid emulsion:
- Soap .... 15 lbs.
- Crude carbolic acid .... 1 pint.
- Water .... 100 gals.

DETAILS OF EXPERIMENTAL OPERATIONS.

The orchard in which the test was made consists of a large variety of apple trees which are from 30 to 35 years of age. There were eighty-three trees in the experiment, of which sixty-nine were sprayed with the different preparations and fourteen reserved as checks. The applications were made on April 18, 19 and 20, when the buds of most varieties were quite green at the tips and still compact, although with some sorts the tips of young leaves were projecting (Plate XXXVII). The trees were thoroughly sprayed, using a power-sprayer with "mistry" nozzles. The average amount of mixture used for each tree was about seventeen and one-half gallons.

EFFECTS OF SPRAYING ON APPLE TREES.

Of the mixtures applied, the soap and nicotine solution was the only combination that did not actually cause some harm to the foliage. There was slight burning of the tips of the most advanced leaves by the lime-sulphur and nicotine, but the injuries were not important and were soon obscured by the new growth. Similar conditions attended the application of the crude carbolic-acid emulsion. In marked contrast with the foregoing sprays very serious damage was caused by sodium sulphide and soap. The destructive properties of this combination were indicated on April 26, six days after the treatment, by the browning of the buds, which, when cut, appeared lifeless and much discolored. At the time of blossoming the buds on these trees generally showed great retardation in their growth, while many of them were evidently dead. Only a few blossoms opened at the normal period, and others that were only partially injured made their appearance one week later. The effects of the treatment were most apparent on the lower branches, while in the upper portions of the trees, especially on the tips of the tallest branches, the conditions of foliage and blossoms were normal. On the other hand, fruit spurs within reach of the operators were oftentimes practically devoid of any signs of life (Plate XXXVIII). On May 18 the dead blossom clusters began to drop and adventitious growth was making its appearance near the base of the buds that were destroyed. Blossom clusters only partially injured showed a few blossoms with stems that were short and of uneven lengths, while the new leaves

were small and few in number. The condition of the trees improved as the summer advanced, by the development of the new growth; but during the entire summer and at the time of harvesting many of the dead blossom buds could be found with little difficulty. The yields of fruit, as was to be expected, were very small on the trees receiving this treatment.

RESULTS OF SPRAYING ON APHIDES.

The conditions of the trees with respect to the oat aphis and rosy aphis were quite similar to those in the preceding experiment, except perhaps that the latter species was slightly more numerous and therefore somewhat more destructive. The spraying with any of the mixtures effected an almost complete destruction of the oat aphis, and with respect to this insect all of the sprayed plats presented great contrast with the unsprayed plats. During the latter part of April and early May the rosy aphis could hardly be said to be abundant, and yet, especially with most of the checks, little difficulty was experienced in finding specimens of the stem-mothers. During June the insect developed rapidly in numbers, and from the relatively few leaf and blossom clusters which constituted the initial centers of infestation, it quickly spread to adjoining leaf and fruit clusters and, as will be observed later, caused considerable damage to some trees. One feature of the activities of the species in this orchard during the season that is deserving of note, was its rapid multiplication on trees where there were only slight evidences of its presence earlier in the season. This largely occurred on the checks, and it is believed that the infestation developed from stem-mothers which had escaped detection during previous observations, as there was no evidence of colonization by migrants of the second generation.

Twenty trees in the sprayed plats and fourteen trees in the check plat were closely examined during July with respect to injuries by the rosy aphis. The data are presented in Table IV.

TABLE IV.— RESULTS OF SPRAYING AGAINST ROSY APHIS.

VARIETY.	Row and tree.	Treatment.	CONDITIONS WITH RESPECT TO INJURIES. Fruit clusters affected.	Terminal shoots affected.	Leaf clusters affected.	Water sprouts affected.	Centers of infestation.	Fruits injured.	Leaves curled.
	No.						No.	No.	No.
Newtown	Row 3, tree 2	Lime-sulphur and nicotine	0	0	0	0	0	0	0
Pease	" 3, " 4	" " " "	0	0	0	0	0	0	0
Winter Banana	" 3, " 6	" " " "	0	0	0	0	0	0	0
Winter Banana	" 3, " 7	" " " "	0	0	0	0	0	0	0
Pumpkin Sweet	" 3, " 12	" " " "	48	36	86	23	193	110	620
Mother	" 3, " 14	" " " "	0	0	0	5	5	0	27
Green Newton Pippin	" 3, " 15	" " " "	6	0	0	8	14	13	60
Northern Spy	" 3, " 16	" " " "	10	23	2	6	41	28	145
Pecks Pleasant	" 3, " 17	" " " "	9	0	13	2	24	14	64
Pewaukee	" 3, " 18	" " " "	0	0	0	0	0	0	0
Pomme Grise	" 3, " 19	" " " "	4	0	9	6	19	6	48
Boikin	" 4, " 3	" " " "	0	0	0	0	0	0	0
Roxbury	" 4, " 4	" " " "	35	39	49	17	140	71	565
Wabash Red	" 4, " 5	" " " "	2	0	0	0	2	2	4
Windsor	" 4, " 6	" " " "	3	5	8	0	16	5	50
Stearns	" 4, " 7	" " " "	0	0	0	0	0	0	0
Esopus	" 4, " 12	" " " "	0	0	0	7	7	0	44
Rhode Island Greening	" 4, " 17	" " " "	13	25	17	15	70	27	305
Currant	" 4, " 18	" " " "	0	0	0	0	0	0	0
Ralls	" 4, " 20	" " " "	11	9	3	15	38	23	149
Kalkidon	" 4, " 22	" " " "	0	0	0	0	0	0	0
Seedling	" 5, " 1	Soap and nicotine	0	0	0	0	0	0	0
Alexander	" 5, " 3	" " "	0	0	0	0	0	0	0

Plate XXXI.— Leaf and Fruit Clusters of Apple Injured by Plant Lice.
(1), Curling of leaves during blossoming period; (2), dwarfing of fruit by rosy aphis, with closing of calyces.

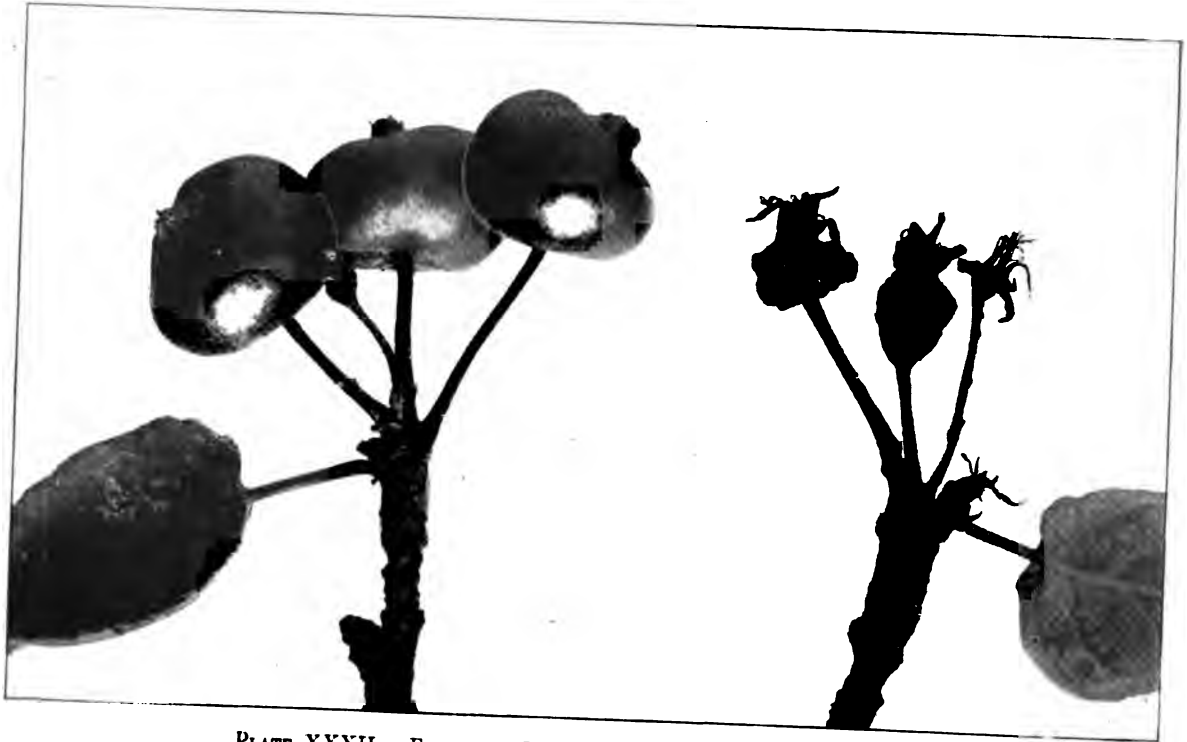

PLATE XXXII.— FRUIT AND LEAF CLUSTERS INJURED BY ROSY APHIS.

PLATE XXXIII.— EFFECTS OF ROSY APHIS ON CONTOUR AND SIZE OF APPLES.

PLATE XXXIV.— CURLING OF LEAVES AND DEFOLIATION BY GREEN APPLE APHIS.

PLATE XXXV.— TYPE OF ROME APPLE TREES IN EXPERIMENTAL PLAT.

PLATE XXXVI.— STAGE OF DEVELOPMENT OF BUDS IN EXPERIMENT AT TIME OF SPRAYING OF ROME APPLES.
(Slightly enlarged.)

PLATE XXXVII.— STAGES OF DEVELOPMENT OF BUDS OF MIXED VARIETIES OF APPLES.

PLATE XXXVIII.— INJURIES TO FRUIT BUDS AND WOOD BY SODIUM SULPHIDE AND SOAP.
Left, Apple; right, peach, sodium sulphide alone.

Greenville	" 5, " 4	" " "	0	0	0	0	0	0	0
Blushed Calville	" 5, " 6	" " "	0	0	0	0	0	0	0
Wheeler	" 5, " 9	" " "	0	0	0	0	0	0	0
Tufts	" 5, " 10	" " "	0	0	0	0	0	0	0
Delicious	" 5, " 21	" " "	0	0	0	0	0	0	0
Breskooke	" 6, " 4	" " "	0	0	0	0	0	0	0
Clayton	" 6, " 7	" " "	0	0	0	0	0	0	0
Delicious	" 6, " 11	" " "	0	0	0	0	0	0	0
Holland Winter	" 6, " 12	" " "	0	0	0	0	0	0	0
Wealthy	" 6, " 13	" " "	0	0	0	0	0	0	0
Ben Davis	" 6, " 14	" " "	0	0	0	0	0	0	0
Late Duchess	" 6, " 15	" " "	0	0	0	0	0	0	0
Rose	" 6, " 17	" " "	0	0	0	0	0	0	0
Seedless	" 6, " 18	" " "	0	0	0	0	0	0	0
Staymann's Winesap	" 6, " 22	" " "	3	9	7	0	19	11	41
Gideon	" 7, " 8	Sodium sulphide and soap	0	0	1	5	6	0	22
Paul Imperial	" 7, " 16	" " " "	0	0	0	0	0	0	0
Washington Strawberry	" 8, " 15	" " " "	0	0	0	0	0	0	0
Ruby Gem	" 9, " 11	" " " "	0	0	0	0	0	0	0
Stark	" 11, " 16	" " " "	30	118	77	64	289	70	1,096
Henry Clay	" 14, " 11	Carbolic acid emulsion...	0	0	0	0	0	0	0
Henry Clay	" 14, " 12	" " " ...	0	0	0	0	0	0	0
Sutton	" 14, " 13	" " " ...	61	38	85	31	215	124	912
Primate	" 14, " 14	" " " ...	0	0	0	0	0	0	0
Henry Clay	" 14, " 15	" " " ...	0	0	0	0	0	0	0
Van Hoy Seedless	" 14, " 17	" " " ...	0	0	0	0	0	0	0
Terry	" 14, " 18	" " " ...	0	0	0	0	0	0	0
Terry	" 14, " 19	" " " ...	0	0	0	0	0	0	0
Parkes Seedless	" 14, " 21	" " " ...	0	0	0	0	0	0	0
Station Seedling	" 14, " 22	" " " ...	0	0	0	0	0	0	0
Hagloe	" 15, " 4	" " " ...	4	0	14	5	23	6	57
Fall Pippin	" 15, " 6	" " " ...	71	23	44	6	144	114	474
Streaked Pippin	" 15, " 7	" " " ...	53	60	59	48	220	120	986
Rhode Island Greening	" 15, " 9	" " " ...	66	54	69	10	199	128	721
Titus Pippin	" 15, " 11	" " " ...	44	9	42	5	100	112	311

TABLE IV.— RESULTS OF SPRAYING AGAINST ROSY APHIS (*concluded*).

VARIETY.	Row and tree.	Treatment.	Conditions with Respect to Injuries. Fruit clusters affected.	Terminal shoots affected.	Leaf clusters affected.	Water sprouts affected.	Centers of infestation.	Fruits injured.	Leaves curled.
	No						*No.*	*No.*	*No.*
Bell Laws Pippin	Row 15, tree 12	Carbolic acid emulsion	0	0	0	0	0	0	0
Early Joe	" 15, " 13	" " "	46	5	20	4	75	106	275
Station Seedling	" 15, " 15	" " "	0	0	0	0	0	0	0
Alexander	" 15, " 16	" " "	0	0	0	0	0	0	0
Jeffers	" 15, " 17	" " "	0	0	0	0	0	0	0
America	" 15, " 19	" " "	0	0	0	0	0	0	0
Orenco	" 15, " 20	" " "	0	0	0	0	0	0	0
Orenco	" 15, " 21	" " "	0	0	0	0	0	0	0
Seedling	" 1, " 1	Check	19	97	44	16	176	20	938
Eiser	" 1, " 3	"	27	4	15	0	46	37	119
Seedling	" 1, " 4	"	*0	95	11	5	111	*0	636
Oswego	" 1, " 7	"	*0	55	33	8	96	*0	608
Alexander	" 1, " 16	"	77	16	11	0	104	223	398
Constantine	" 1, " 20	"	2	47	78	8	135	3	620
Schoharie	" 2, " 1	"	45	62	6	14	127	95	757
Jersey Black	" 2, " 4	"	63	20	50	0	133	93	495
Maiden Blush	" 2, " 14	"	222	208	132	30	592	689	2,342
Jersey Sweet	" 2, " 15	"	418	141	200	69	828	1,218	3,580
Hurlburt	" 2, " 17	"	2	142	114	60	318	9	1,365
Gravenstein	" 2, " 19	"	92	91	132	8	323	237	1,183
Striped Fameuse	" 2, " 20	"	1	8	2	1	12	3	37
Green Newtown	" 2, " 22	"	38	34	7	1	80	156	242

* No fruit on trees.

TABLE V.— SUMMARY OF EXPERIMENTS AGAINST ROSY APHIS.

TREATMENT.	Number of trees.	Centers of infestation.	Fruits injured.	Leaves curled.
		No.	*No.*	*No.*
Lime-sulphur and nicotine solution...	21	569	299	2,081
Nicotine solution and soap..........	17	19	11	41
Sodium sulphide and soap..........	5	295	70	1,118
Carbolic acid emulsion.............	23	976	710	3,736
Check, no treatment...............	14	3,081	2,783	13,320
AVERAGES PER TREE.				
Lime-sulphur and nicotine solution.............		27	14	99
Nicotine solution and soap....................		1	1—	3
Sodium sulphide and soap....................		59	14	224
Carbolic acid emulsion........................		42	31	162
Check, unsprayed trees........................		220	199	951

DISCUSSION OF RESULTS.

Observations at frequent intervals during the early summer could hardly fail to leave in the mind of the observer the impression that all of the treatments had brought about greatly improved conditions in the sprayed plats. However, in the interpretation of the statistical data as regards the rosy aphis, the test has one defect that does not appear in Experiment I, — that the orchard consists of many varieties which are not equally distributed, if at all, among the different plats. With the small amount of knowledge that exists as to the susceptibility of different sorts of apples to aphides, the preliminary character of the experiments may be again emphasized. An important phase of our work has been to devise satisfactory methods of conducting experimental operations against these pests, and discrepancies and errors due to differences in varietal susceptibility will best be determined by repetition of the experiments under varying conditions. Most commercial orchards consist of several varieties, and none of our leading sorts of apples are immune to attack. In this particular planting, the rosy aphis has been very abundant during certain years, and the general behavior of different varieties to the pest may be fairly gauged by the conditions of the checks, among which there is not a variety which does not show more or less infestation. In the main the effects of spraying in this orchard were not dissimilar from those of other similar operations recorded in the bulletin. The results so summarized are regarded as indicating

of the succulent shoots. The lower leaves were not subject to infestation for a lengthy period and therefore showed little evidence of permanent injury. Such as there was consisted apparently of little more than a slight incurving of the margins of the leaves. During the latter part of July and August when the production of new growth was less rapid the effects of accumulated injuries became increasingly apparent. The foliage of the badly-infested shoots showed curled and distorted leaves, which were discolored and smutty as a result of honey dew and the sooty fungus. Later, there was more or less browning of the leaves, followed by a slight defoliation. Occasionally there were examples of more extreme forms of injuries as dwarfing or killing of the tips of the new growth, which in some instances were extensive enough to destroy the symmetry as well as to cause stunting of the trees.

As to the comparative insecticidal properties of the various spraying mixtures there was very little difference in effectiveness. Nicotine and soap possess superior spreading and wetting properties and always showed an increased rate of toxicity over the other preparations. The destructive action of lime-sulphur and nicotine solution or lime and nicotine solution was appreciably slower but generally the final results on the pests were very satisfactory.

LIME AS AN APHIDICIDE.

One result of the comparative tests of the foregoing insecticides that deserves more specific mention is the value of lime or whitewash in protecting foliage from plant lice and leaf-hoppers. Such contact insecticides as soap, oil emulsions or nicotine solutions, excellent as they are as aphidicides, are in one respect very deficient against such a pest as the green apple aphis—their toxicity ceases as soon as the spraying mixture dries on the foliage. Failure to destroy all of the insects or invasion of the planting by winged forms frequently results in a reinfestation, when repetition of the treatment becomes necessary. The extreme need of more lasting properties led to experiments with lime in combination with nicotine solution. With this mixture immediate results were obtained as usual by the nicotine, while, in addition, the lime, through the heavy coating of the foliage, was found to be very repellent to the insects. In the plats as described, the trees receiving this treatment showed throughout the entire summer a degree of freedom from

aphides and a vigor of growth that was hardly equalled by any treated with other insecticides. The leaves that had their undersurfaces thoroughly coated with the whitewash were not only largely exempt from attack by plant lice but they were also quite immune from such species of leaf-hoppers as the apple leaf-hopper (*Empoasca mali*) or the rose leaf-hopper (*Typhlocyba rosæ*). In pear orchards similar results were obtained against the pear psylla. Directions for using lime as an aphidicide are withheld, pending experiments to determine its ranges of usefulness for this purpose, and the conditions under which it may be satisfactorily employed.

AUXILIARY EXPERIMENTS DURING 1915.

Through the courtesy of Commissioner Charles S. Wilson the auxiliary experiments for this year were conducted largely under the personal direction of Mr. L. F. Strickland, Inspector of the State Bureau of Horticulture for Niagara County, and Mr. A. B. Buchholz, Horticultural Inspector for Orleans County. The principal details of these tests are briefly summarized as follows:

EXPERIMENTS IN NIAGARA COUNTY.

Test 1. Orchard of E. S. Gifford, Gasport.—In this planting twenty-two trees of the variety Greening, about sixty years old, were reserved for the test. On April 22, as the buds were green at the tips and in some instances the ends of the young leaves were breaking out, the trees were sprayed with lime-sulphur in combination with nicotine solution (Black Leaf 40) in the usual proportions. All three species of the aphides were present on the trees, and the buds showing green tissues in the more advanced stages of growth harbored in some instances as high as twenty-five to eighty of the newly-hatched nymphs. The greater part of the infestation was in the upper branches, but a small percentage of the creatures was on the lower fruit spurs. The oat aphis and green aphis were the most abundant species, and only occasionally was a specimen of the rosy aphis observed. In order to insure thorough treatment the trees were drenched with three hundred thirty gallons of the spraying mixture, which makes an average of fifteen gallons of the liquid to the tree.

An examination of the plat on May 12 showed only scattering numbers of the three species of plant lice on the sprayed trees, while

neighboring unsprayed trees were badly infested with the oat aphis, which had developed to considerable numbers since the time when the test was begun. Varying numbers of the green aphis and rosy aphis, though usually not large in extent, were detected on the checks. On June 5 there was an apparent improvement in the conditions of the unsprayed trees on account of the new growth and the migration of the oat aphis to its summer hosts. The rosy aphis was slightly more conspicuous than before and was curling some leaves on all of the trees, but at this date there were more affected leaves and larger numbers of the insects on the check trees. This insect increased in numbers during succeeding days, and on July 17 an examination of the sprayed plat showed one tree entirely free from infestation and twenty-one trees with varying numbers of affected fruit and leaf clusters, which in the main were few when considered on the basis of the great size of the trees in this orchard and the conditions of the checks with respect to injuries by the rosy aphis.

Test 2. Orchard of C. D. Tabor, Wilson.—In this planting forty-three trees of the variety Baldwin, about thirty-five years old, were sprayed on April 23 with lime-sulphur and nicotine solution (Black Leaf 40) in the proportions commonly recommended. To this plat two hundred eighty gallons of the spraying mixture were applied, making an average of six and one-half gallons of the liquid to each tree. At the time of treatment the young aphides, especially of *avenæ* were abundant on the green tips of the opening buds. Green aphis occurred in sparse numbers. The rosy aphis was not detected at this time notwithstanding the species caused serious damage during the preceding year. On May 21 the sprayed plat was entirely free of all three species of aphides, while the checks showed only occasional colonies of the oat aphis. On July 10 the conditions of sprayed plats remained unchanged, while a few colonies of the rosy aphis were detected on some of the checks. These trees, however, were generally free of the insects during the entire season and at the conclusion of the test no appreciable differences between treated and untreated trees could be detected.

Test 3. Orchard of B. S. Harwood, Appleton.—This experiment was conducted in a plat of thirty-six Greenings, which were fifty years of age and of unusual height, besides showing great horizontal growth of the lower limbs. The orchard is carefully sprayed each

year and has been well managed in all respects. It has the reputation of producing annually large yields of fruit. Owing to the height of the trees special towers have been constructed for the spraying machines so that the tops of the trees may receive thorough treatment. The applications of lime-sulphur and Black Leaf 40 were given on April 22 and 23, at which time the buds were green at the ends, and in the protected portions some of the young leaves had actually begun to separate. The buds were thickly covered with newly-hatched lice, principally the oat aphis, and scattering numbers of the rosy aphis. Apparently the green aphis was not present on the trees. In spraying, the trees were thoroughly wetted with the mixture, which was applied at the rate of fourteen gallons per tree. On May 15 a few specimens of the oat aphis and rosy aphis were observed in the treated plat, while on the checks the insects, especially the oat aphis, were abundant. On May 21 the differences between the two lots of trees were more marked. Scattering numbers of both species were on the treated trees. Occasional clusters of fruits showed evidences of injury, while the checks revealed greater numbers of the insects and considerably more clusters of deformed apples. On July 15 there was a greater contrast in the conditions of the trees owing to the fact that many of the affected leaves on the checks were turning yellow or were blackened by the sooty fungus, causing portions of the trees to present a sickly appearance. For the most part the sprayed trees showed relatively little curling of the leaves and the foliage had a vigorous, healthy appearance. In order that there might be more detailed knowledge regarding the effects of the spraying, counts were made of the affected leaf and fruit clusters of all the trees in the sprayed plat and two representative trees of the check plat. The data are presented in Table VI.

Test 4. Orchard of F. L. Backus, Olcott.—This test was conducted in a plat of thirty-two Greening trees, which are about twenty-six years old. The orchard of which the experimental plat is a part has been carefully managed and the trees, from their size, have the appearance of being considerably older than they really are. The spraying was made on April 21, using lime-sulphur and Black Leaf 40 at the rate of twelve gallons per tree. At this time the buds were well advanced, most of them being quite compact, although they showed green tissues at the tips. Occasional buds showed a

TABLE VI.— RESULTS OF SPRAYING AGAINST ROSY APHIS.

VARIETY.	Row and tree.	Treatment.	CONDITIONS WITH RESPECT TO INJURIES. Fruit clusters affected.	Terminal shoots affected.	Leaf clusters affected.	Water sprouts affected.	Centers of infestation.	Fruits injured.	Leaves curled.
							No.	No.	No.
Greening	Row 2, tree *1	Lime-sulphur and nicotine	0	0	18	4	22	0	140
"	" 2, " 3	" " " "	16	0	0	0	16	40	96
"	" 2, " 5	" " " "	3	0	18	0	21	3	100
"	" 2, " 7	" " " "	24	0	0	13	37	41	235
"	" 2, " *9	" " " "	0	0	1	0	1	0	3
"	" 2, " 11	" " " "	8	0	0	0	8	8	42
"	" 2, " 15	" " " "	3	0	0	0	3	5	16
"	" 2, " 17	" " " "	10	0	34	0	44	15	144
"	" 2, " 19	Check	39	0	110	0	149	143	724
"	" 3, " *2	Lime-sulphur and nicotine	0	0	0	3	3	0	20
"	" 3, " 4	" " " "	23	0	0	0	23	42	108
"	" 3, " 6	" " " "	10	0	0	0	10	16	55
"	" 3, " 8	" " " "	17	0	0	12	29	28	157
"	" 3, " 10	" " " "	7	0	0	26	33	9	302
"	" 3, " 12	" " " "	11	0	0	27	38	38	251
"	" 3, " *14	" " " "	0	0	0	1	1	0	7
"	" 3, " 16	" " " "	7	0	0	21	28	7	147
"	" 3, " *18	Check	0	0	125	0	125	0	734

* Tree produced no crop this season.

separation of the tips of the young leaves but none were sufficiently opened to afford protection to the insects. The infestation of buds in this orchard was greater than in any other of the experimental plats this season in this county. The insects were largely oat aphides, among which were scattering numbers of the rosy aphis. The green apple aphis was not detected.

As will be observed, some of the trees that were sprayed did not set fruit, while the two checks in both cases produced goodly numbers of apples. On May 21 the latter showed considerably greater infestation than any of the treated trees. On July 10 there was more or less curling of leaves on the sprayed trees, but the foliage was generally of good color and presented a healthy appearance. The checks at this date showed decidedly inferior conditions as the larger numbers of leaves that were infested were now either discolored by sooty fungus or becoming brownish, which caused the trees to appear sickly. Besides, there was more stunted fruit, and the clusters of small, deformed apples were visible in all portions of the trees. Because of the contrast in the conditions of the two lots of trees, close examination was made of each tree and all centers of infestation noted. The data as tabulated are given in Table VII.

EXPERIMENTS IN ORLEANS COUNTY.

Test 5. Orchard of H. H. Freeman, Kent.—There was set apart in this orchard a block of seventy-two Greening trees, averaging 30 to 35 years of age, of which three trees were reserved as checks. The orchard had been in sod for a number of years until the spring of 1915, when clean cultivation was adopted. The trees were well pruned and put into excellent condition for spraying, in which respects they had heretofore been neglected.

The aphides were very abundant on the trees and the opening buds were thickly covered with the creatures, which could be found on almost every blossom bud. The oat aphis especially and the green aphis were the most numerous, although the rosy aphis was pretty well scattered over the trees. The oat aphis had evidently hatched several days before the date of treatment as shown by individuals of this species in the second stage.

The experimental plat was sprayed on April 22 at which time the buds were well advanced and many of the leaves of the terminal buds were beginning to separate. Those, however, in the more ad-

TABLE VII.— RESULTS OF SPRAYING AGAINST ROSY APHIS.

VARIETY.	Row and tree.*	Treatment.	CONDITIONS WITH RESPECT TO INJURIES.				Centers of infestation.	Fruits injured.	Leaves curled.
			Fruit clusters affected.	Terminal shoots affected.	Leaf clusters affected.	Water sprouts affected.	No.	No.	No.
Greening	Row 1, tree 1	Lime-sulphur and nicotine	0	0	13	0	13	0	72
"	" 1, " 2	" " " "	0	0	18	0	18	0	90
"	" 1, " 3	" " " "	0	0	25	0	25	0	125
"	" 1, " 6	" " " "	4	0	0	0	4	12	20
"	" 1, " 7	" " " "	15	0	43	0	58	15	280
"	" 1, " 8	" " " "	15	0	16	0	31	15	180
"	" 1, " 10	" " " "	5	0	7	0	12	5	40
"	" 1, " 11	" " " "	1	0	16	0	17	1	85
"	" 1, " 12	" " " "	2	0	17	0	19	2	76
"	" 1, " 13	" " " "	0	0	25	0	25	0	142
"	" 1, " 14	" " " "	5	0	73	5	83	19	305
"	" 1, " 15	" " " "	6	0	14	5	25	6	108
"	" 1, " 16	" " " "	0	0	9	1	10	0	88
"	" 2, " 1	" " " "	4	0	19	0	23	12	103
"	" 2, " 2	" " " "	0	0	107	0	107	0	421
"	" 2, " 3	" " " "	11	0	0	0	11	40	60
"	" 2, " 4	" " " "	14	0	13	0	27	14	55
"	" 2, " 5	" " " "	5	0	37	0	42	25	160
"	" 2, " 7	" " " "	0	0	20	0	20	0	100
"	" 2, " 8	" " " "	0	0	11	2	13	0	102
"	" 2, " 9	" " " "	0	0	12	0	12	0	51
"	" 2, " 11	" " " "	2	0	39	0	41	2	198
"	" 2, " 12	" " " "	6	0	30	0	36	0	200
"	" 2, " 13	" " " "	8	0	17	0	25	0	105
"	" 2, " 14	" " " "	0	0	9	0	9	0	32
"	" 2, " 15	" " " "	0	0	7	0	7	0	23
"	" 2, " 16	" " " "	1	0	28	0	29	1	61
"	" 3, " 1	Check	121	0	642	0	763	686	3,052
"	" 3, " 2	"	800	0	0	0	800	987	3,800

vanced stages of growth were still compact and were not sufficiently opened to afford protection to the young aphides. Lime-sulphur and Black Leaf 40 at recommended strengths was applied as a coarse, drenching spray, using the material at the rate of ten gallons per tree.

On April 28 it was quite difficult to find aphides of either species on the sprayed trees. No individuals of the oat aphis were observed, but they were abundant on the checks. Scattering individuals of the rosy aphis occurred in the treated plat, while on the checks they were fairly numerous. On May 20 occasional colonies of rosy aphis were noted on the sprayed trees, while the checks were becoming quite seriously infested. As on the previous date, the sprayed plat was entirely free of the oat aphis. Quite similar conditions prevailed on June 16, at which time comparatively few of the leaves of the treated trees showed evidences of infestation, and the foliage was dense and of a healthy appearance. On the contrary the checks revealed considerable numbers of curled leaves. Unfortunately, very few fruits set on any of the trees but, as it was, the untreated trees showed a larger number of "cluster" apples. By July 14 the rosy aphis had entirely disappeared, at which time the work of the aphides on the check trees was plainly manifested by the discolored leaves, which were then dropping. An examination was made of each tree in the experimental plat, and the data as collected are tabulated in Table VIII.

Test 6. Orchard of John Larwood, Albion. — There was chosen for this test a block of fifty-eight Baldwin apple trees averaging from 35–40 years of age. The orchard to which they belong is regularly sprayed and tilled. Until the present season no special treatment has been made to combat the different aphides that attacked the fruit and foliage, notwithstanding important losses have been occasioned by these pests. On April 22 when the spraying operations commenced, the buds, though showing green tissues at the ends, were for the most part still compact. Occasionally the terminal buds were somewhat more advanced, and showed tips of leaves. Owing to a warm rain and high temperatures the trees made a rapid growth and by the following day many buds showed young leaves that were well apart at the tips. Plant lice were present in large numbers on the majority of the trees, and these belonged chiefly to the green apple aphis and the oat aphis. The spray was a combination of

TABLE VIII.— RESULTS OF SPRAYING AGAINST ROSY APHIS.

VARIETY.	Row and tree.	Treatment.	CONDITIONS WITH RESPECT TO INJURIES. Fruit clusters affected.	Terminal shoots affected.	Leaf clusters affected.	Water sprouts affected.	Centers of infestation.	Fruits injured.	Leaves curled.
							No.	No.	No.
Greening	Row 1, tree 1	Lime sulphur and nicotine	0	0	0	0	0	0	0
"	" 1, " 2	" " " "	0	0	0	0	0	0	0
"	" 1, " 3	" " " "	0	0	7	0	7	0	42
"	" 1, " 4	" " " "	0	0	11	0	11	0	42
"	" 1, " 5	" " " "	2	0	3	0	5	4	15
"	" 1, " 6	" " " "	1	0	4	15	20	3	99
"	" 1, " 7	" " " "	12	0	5	8	25	24	110
"	" 1, " 8	" " " "	0	0	18	5	23	0	74
"	" 1, " 9	" " " "	0	0	4	0	4	0	18
"	" 1, " 10	" " " "	0	0	9	19	28	0	175
"	" 1, " 11	" " " "	3	0	26	0	29	9	110
"	" 1, " 12	" " " "	0	0	12	6	18	0	99
"	" 1, " 13	" " " "	0	0	23	0	23	0	92
"	" 2, " 2	" " " "	0	0	4	6	10	0	45
"	" 2, " 3	" " " "	3	0	14	11	28	6	124
"	" 2, " 4	" " " "	0	0	1	1	2	0	7
"	" 2, " 5	" " " "	0	0	2	1	3	0	14
"	" 2, " 6	" " " "	0	0	6	1	7	0	20
"	" 2, " 7	" " " "	2	0	10	49	61	5	334
"	" 2, " 8	" " " "	4	0	4	3	11	8	44
"	" 2, " 9	" " " "	0	0	0	1	1	0	6
"	" 2, " 10	" " " "	0	0	7	0	7	0	22
"	" 2, " 11	" " " "	2	0	10	39	51	4	328
"	" 2, " 13	Check	20	0	147	7	174	60	813
"	" 1, " 14	"	39	0	58	42	139	94	823
"	" 2, " 1	"	22	0	122	43	187	31	812

lime-sulphur, arsenate of lead and Black Leaf 40, which were used at standard strengths. The mixture was applied as a coarse, driving spray at the rate of ten gallons to a tree.

On April 24 it was difficult to find live aphides on the sprayed trees, and dead individuals, ranging as high as ten specimens to a bud, could be observed with little difficulty. On May 20 the sprayed plat was quite free of infestation by the insects and that which occurred consisted of occasional leaf clusters occupied by the oat aphis. One small branch only was infested with the rosy aphis. No specimens of the green aphis were detected. On the other hand, the checks harbored considerable numbers of the oat aphis, and while not numerous, the rosy aphis was more conspicuous than on the sprayed trees. At the time of the final examination on June 16 the treated plat showed only an occasional injured cluster, and while the conditions in this respect were better than with the checks, the differences in the two lots of trees were not marked.

Test 7. Orchard of John Beckwith, Lyndonville.— There was reserved in this planting a block of fifty large Greenings, about forty years old. The careful attention given to this orchard seems to have made the trees increasingly susceptible to rosy aphis in spite of special treatments to control the pest. On April 21, when the test was begun, the buds were well advanced, showing generally green tissues at the ends. While in some instances the tips of young leaves had separated, lime-sulphur, with Black Leaf 40, was applied at the rate of twenty-two gallons per tree. At the time of spraying, the buds were well infested with aphides, varying from fifteen to fifty of the insects on the buds in the most advanced stages of growth. The oat aphis and the green apple aphis were most abundant, and subsequent events showed that the rosy aphis must also have been quite plentiful. As it was not deemed desirable to leave untreated trees in this orchard, a plat of Greenings across a lane was left unsprayed to serve as check.

On May 28 the unsprayed trees were abundantly infested with all three species of aphides while the sprayed trees were quite free of the insects, showing only scattering colonies of the oat aphis and the rosy aphis. By June 16, great differences developed between the sprayed block and the adjacent unsprayed Greenings. The contrast was due to the relatively larger number of small, deformed apples on the untreated trees and the sickly appearance of the

affected leaf clusters, many of the leaves of which were turning yellow and dropping.

Test 8. Orchard of H. B. Gibson, Albion.— Twenty-three trees were reserved for the test in this orchard. These were Greenings, about thirty-seven years old, which, with the remainder of the planting, have received systematic attention with respect to cultivation, spraying, etc. No efforts have in the past been made to control plant lice, which during some years have caused considerable damage to fruit yields. The spraying was not attempted until April 24, when the development of the buds was more pronounced than in any other of the experimental plantings. Many of the outer leaves of the buds had separated at the ends and had grown to considerable size. On the whole, the aphides were not abundant, although they were well distributed among the different trees, ranging generally from one to ten of the creatures to a bud. Most of them belonged to the oat aphis, but intermixed with these there were scattering numbers of the rosy aphis. The spraying mixture consisted of lime-sulphur, arsenate of lead and Black Leaf 40 in combination, which was applied at the rate of nine gallons per tree.

During the period of April 28 to May 4 the insects were not numerous on any of the trees, irrespective of the treatment they had received. By May 20 occasional colonies of rosy aphis were observed on the sprayed trees, while the checks showed evidences of considerable infestation. When the final examination was made on July 15 there was no appreciable evidence of injury to the foliage of the treated plat, while the checks showed extensive curling of the leaves, some of which were turning yellow or brownish and dropping. Conditions of the trees with respect to fruit injuries by the rosy aphis are indicated in the accompanying table.

Test 9. Orchard of G. E. Snyder, Albion.— This planting has sustained great losses from the rosy aphis, and the attacks have been most severe in a block of Greenings with some Holland Pippins used in this experiment. The trees are about 35–40 years of age. The spraying was done on April 22, at which time the buds were well advanced and tips of young leaves were beginning to separate. The oat aphis and the green apple aphis were well distributed among the buds, and while not as numerous as the foregoing species, the rosy aphis was fairly abundant on the lower areas of the trees. In general the infestation of the buds by the different aphides was lighter than in

TABLE IX.— RESULTS OF SPRAYING AGAINST ROSY APHIS.

VARIETY.	Row and tree.	Treatment.	Conditions with Respect to Injuries. Fruit clusters affected.	Terminal shoots affected.	Leaf clusters affected.	Water sprouts affected.	Centers of infestation.	Fruits injured.	Leaves curled.
							No.	No.	No.
Greening	Row 1, tree 1	Lime sulphur and nicotine	0	0	0	0	0	0	0
"	" 1, " 2	" " " "	0	0	2	4	6	0	33
"	" 1, " 3	" " " "	2	0	5	9	16	6	81
"	" 1, " 4	" " " "	5	0	0	4	9	12	32
"	" 1, " 5	" " " "	0	0	0	13	13	0	100
"	" 1, " 6	" " " "	9	0	10	9	28	18	130
"	" 1, " 7	" " " "	0	0	0	2	2	0	4
"	" 1, " 8	" " " "	0	7	7	2	16	0	37
"	" 2, " 1	" " " "	17	0	14	4	35	33	118
"	" 2, " 2	" " " "	0	0	3	0	3	0	10
"	" 2, " 3	" " " "	0	0	1	7	8	0	36
"	" 2, " 4	" " " "	4	0	7	9	20	10	114
"	" 2, " 5	" " " "	0	0	0	1	1	0	2
"	" 2, " 6	" " " "	0	0	2	6	8	0	32
"	" 2, " 7	" " " "	0	0	8	0	8	0	22
"	" 3, " 1	Check	88	0	37	0	125	225	467
"	" 3, " 2	"	48	0	24	12	84	87	314
"	" 3, " 3	"	14	0	24	16	54	23	400

the other experiments. The spraying mixture consisted of lime-sulphur, arsenate of lead and Black Leaf 40 in the usual proportions, and was applied as a mist-like spray at the rate of 14 1-2 gallons per tree.

On April 28, as the blossom buds were showing pink, it was difficult to find aphides on either the sprayed or unsprayed trees. By May 19 the insects were more conspicuous and both the oat aphis and the rosy aphis were quite plentiful on the checks, while scattering numbers of the latter species were observed on the treated trees. On June 16 the infestation was light in both cases, and while there was not any material damage there were however fewer evidences of affected leaf and fruit clusters on the sprayed plat than on the check trees. Conditions similar to the foregoing existed until July 16, the date of the last examination, except that the checks showed more browning and dropping of leaves, which were, however, unimportant in extent.

Test 10. Orchard of Lynn Burrows, Albion.— This test was made in a planting of one hundred trees of Wealthy, interplanted with Duchess. The trees are twelve years old and are, because of the careful attention they have received, large for their age. For the past seven or eight years aphides have been very abundant and have checked the growth of some of the trees. Spraying was done on April 23 with lime-sulphur, arsenate of lead and Black Leaf 40 in the usual proportions, using two gallons of the mixture per tree. The buds were green at the ends and generally infested with plant lice, the oat aphis being the most numerous of the three species.

On April 28 few lice could be found on the sprayed block, while the checks showed much greater infestation. An examination on May 19 found the treated trees quite free of the insects, while the checks were generally infested with aphides, among which were scattering numbers of the rosy aphis. Similar conditions prevailed as late as July 14, when the sprayed plat was still in an excellent state of health.

DISCUSSION OF RESULTS OF AUXILIARY EXPERIMENTS.

The rosy aphis was not generally injurious in most of the apple orchards in Niagara and Orleans counties. As was, however, the experience of individual growers, the insect was quite abundant in a number of the orchards under experiment. In two of the auxiliary tests the rosy aphis was of no importance, while in the remaining plant-

ings, eight in number, the pest caused more or less damage. The trees which were sprayed as the buds were expanding showed, on the whole, appreciable benefits from the treatments. While in all of the experiments there were slight infestations on many of the sprayed trees, the injuries by the insects were scattered and there were no important losses in fruit yields. The general conditions of the trees following the spraying were, as compared with the appearances of the checks, excellent.

METHOD OF TREATMENT.

FORMULAS FOR SPRAYING MIXTURES.

FORMULA I, NICOTINE SOLUTION.

Nicotine solution 40 per ct.	¾ pt.
Water	100 gals.
Soap	3 to 5 lbs.

FORMULA 2, KEROSENE EMULSION.

Kerosene	2 gals.
Fish-oil soap	½ lb.
Soft water	1 gal.

Directions for making kerosene emulsion are as follows:

Dissolve the soap, which has been finely divided, in one gallon boiling water. Remove the vessel from the stove and add the oil. Then agitate the mixture violently for from three to five minutes by pumping into itself under high pressure until a creamy mass is formed, from which the oil does not separate. Fruit growers are advised not to employ an emulsion which shows a separation of the oil as application of such preparations may cause injuries to the trees. This is used with success by some growers for summer spraying against the lice at a dilution of one gallon of the emulsion to eight gallons of water.

FORMULA 3, FISH OIL SOAP.

Fish oil soap	12 to 20 lbs.
Water	100 gals.

To prepare for use, slice the soap and dissolve in boiling water. Soap varies greatly in its water content, and before undertaking extensive operations the grower should make a preliminary test to determine the amount of material required to make an efficient spray, judging by the effects of the dilution on insects and foliage.

FORMULA 4, CARBOLIC ACID EMULSION.

Fish-oil soap	15 lbs.
Carbolic acid (crude)	1 pt.
Water	100 gals.

Dissolve the soap in a small quantity of water. Add the carbolic acid in small quantities at a time, stirring vigorously.

COMBINATIONS OF SPRAYING MATERIALS.

Many pests of fruit trees pursue their injurious activities at similar periods of time and some of them are jointly susceptible to a single application of an insecticide or to a combination of spraying materials. As the expense of insecticides is usually much less than the cost of labor and team, it is desirable from the standpoint of economy and time to reduce the number of applications to the minimum. One means to this end is to employ combination mixtures or, as they are popularly called, "two in one" or "three in one" sprays, according to the number and nature of constituents contained in them.

From the standpoint of safety to expanding buds and leaf tissues, and effectiveness against insects, the most satisfactory combination is three-fourths of a pint of nicotine solution (40 per ct.) to one hundred gallons of lime-sulphur solution at winter strength for bud treatment or to one hundred gallons of lime-sulphur at summer strength with arsenate of lead for foliage applications. While this combination lacks somewhat the spreading properties of soap mixtures, oil emulsions or nicotine solution with soap, this deficiency is probably more than compensated by the saving in labor in avoiding an extra application and by the thoroughness of spraying in the bud treatment when lime-sulphur is directed also against the San José scale. Drenching of the trees with this combination as the buds are breaking may injure the tips of the unfolding leaves. However, the damage is usually inconsequential and should cause no apprehension.

DIRECTIONS FOR SPRAYING.

On the basis of the experiments conducted by this Station the most promising means of combating the lice is a thorough spraying of the trees at the time when the insects are assembled on the ends of the buds showing green and while the buds are compact and the tips of the

unfolding leaves are barely showing. (See Plate VI.) As the creatures that appear on the opening buds are the progenitors of many broods that are to follow, and constitute the first and only forms that infest leaf and fruit clusters at this period, special efforts should be made to allow as few as possible of these insects to escape this treatment. To this end apply the spraying mixture in liberal quantities and under high pressures, using nozzles with rather coarse apertures and endeavoring to wet all of the buds thoroughly.

TIMING OF SPRAYING OPERATIONS.

It is common knowledge that varieties differ as to the time of opening of buds, and that trees of the same variety may show retarded or accelerated growth, according to the conditions of their environment. For these reasons the grower needs to take into consideration the stages of growth of the different varieties, waiting until the lice are massed on the opening buds and keeping in mind the importance of killing the insects before they obtain protection in fuzzy, unfolding leaves of the opening buds.

LATER APPLICATIONS.

The grower should endeavor to combat the pests by the foregoing measures and thus avoid, if possible, the necessity of later sprayings. If bud treatment has been omitted or this application has not given entirely satisfactory results, one should spray with one of the foregoing mixtures as soon as the aphides are detected in numbers, endeavoring by high pressures to reach as many of the creatures as possible. Since curling of the leaves and production of the second generation begin at the time of blossoming it appears from experiments to date that the supplementary treatment should be made before blossoming preferably or soon after the petals drop. There are serious objections to spraying during late May or early June because of the danger of early injuries to fruit and leaf clusters and the difficulty of reaching the lice in the curled leaves, which becomes greater as the infestation increases. The protection gained by this spraying will afford some measure of relief and perhaps tide the trees over a critical period.

THE CABBAGE MAGGOT: ITS BIOLOGY AND CONTROL.*

W. J. SCHOENE.†

SUMMARY.

The cabbage maggot (*Phorbia brassicæ* Bouché) has been known in America and in northern Europe for more than eighty years. During this long period it has been regarded as the most important injurious pest of such cruciferous vegetables as cabbage, radish, cauliflower and turnip. The insect is widely distributed and ever present, but it resembles certain native species in that the damage it causes fluctuates from year to year. Some seasons entire crops are destroyed, while at other times the insects are difficult to find and are of little importance.

The insect in America is an introduced species. It has been reported many times as injurious in Norway, Sweden, Denmark, Holland and the British Islands, but the species seems not to have attracted attention in France or Italy. In North America the cabbage maggot ranks as an important insect in Canada and the northern tier of states of the United States, but has only occasionally been reported in sections further south. The cabbage maggot is a northern insect and, like its host, attains maximum development in a cool, moist climate. Serious injury has rarely been reported south of latitude 45° in North America and latitude 40° in Europe.

The known host plants of this insect in North America have been naturalized from Europe. It is supposed that the maggots were introduced at an early date by turnips used on ships or by the importation of infested roots for food. It is even more likely that the pupa stage of the insect was imported by the use as ship ballast of soil that contained puparia. The latter assumption is made because a number of cruciferous weeds have evidently been imported by the same means.

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The white egg, 1.1 mm. long, marked with longitudinal furrows, is deposited on or near succulent cruciferous plants. Three to five days later the larva appears and attacks the sound tissue of the root or that part of the plant devoid of chlorophyl. Eighteen to twenty days are required for the larva to mature. It has an average length of about 7 mm. When mature the larva enters the soil to pupate. The pupal stage may last from twelve to eighteen days, or may be prolonged for an indefinite period of several months. The females begin to oviposit soon after emerging, probably within three to five days. Adults may live for five or six weeks.

The insect hibernates in the pupa stage. The over-wintering pupæ finish their development in the spring and the adults begin to emerge about the time the Windsor cherry blossoms. The flies continue to emerge over a period of four or five weeks, and those that appear in the spring are largely the adults of the fall brood of larvæ, though a few originate from the first and second broods of larvæ of the previous summer.

When conditions are favorable there are at least three broods and perhaps a partial fourth brood. However, the summer temperatures that frequently occur during July and August in western New York are unfavorable to the normal development of the insect, and seem to cause a retardation which may last until the weather becomes cool. High temperatures affect the insect both directly and indirectly. The roots of cabbage and other cruciferous plants become tough and woody at the appearance of hot weather, so that the larvæ grow very slowly. Also, it appears that the weather may directly influence the pupal stage and that this period may be lengthened or shortened so that the insect may be one-, two- or three-brooded. This situation has been interpreted in the same way as that outlined by various writers for the Hessian fly, which is, namely, that high temperature or severe drought causes a retardation of the developing larvæ and pupæ. It is probable that the optimum temperature for the development of the pupæ is around 80° F. for the average maximum temperature and 55° for the minimum.

The cabbage maggot derives its reputation as an injurious insect largely from its attacks in the spring of the year on cabbage seedlings, radishes and early cabbage. The activities of the insect during the autumn, when feeding upon turnips and sprouted cabbage, have been largely overlooked. Our studies show that the presence

both in spring and fall of large acreages of succulent cruciferous roots is a condition necessary for the cabbage maggot to occur in great numbers.

The insect has a number of natural enemies, some of which have a wide distribution in North America and have probably been imported in soil used as ship ballast. The principal enemies are certain staphylinids of the genus *Aleochara*, a cynipid parasite, *Pseudoeucoila gillettei*, and perhaps several species of mites of the genus *Trombidium*.

The cabbage maggot is amenable to treatment. Cabbage growers have been able to secure cabbage seedlings free from injury at a very small cost by the use of cheesecloth screens. Truck gardeners have been successful in preventing serious losses to their fields of early cabbage by employing tar-paper disks. The removal of all crop remnants when the cruciferous crops are harvested and the destruction of cruciferous weeds will lessen the numbers of the insect in any community.

INTRODUCTION.

The root-inhabiting maggots that affect cruciferous crops have for more than eighty years ranked as injurious insects in those sections of the northern states and Canada and northern Europe devoted to the culture of cabbage and related crops. The insects are ever present and widely distributed but the injuries vary in different localities and from year to year. Some communities suffer more than others, the attacks being both more frequent and more severe. During the periods when the insects are present in unusual numbers, crops are often largely if not entirely destroyed. Because of these injuries some gardeners have abandoned the growing of radishes, except perhaps the very earliest varieties. Also, to secure a satisfactory stand of early cabbage two or three times as many plants are set as are needed, and even then the toll required by the insects is such that the crop is often a failure. For, in addition to the death of some of the plants, there is, besides, a certain amount of root injury that dwarfs and retards the remainder of the crop. Growers of late cabbage in some localities have, in years when the insect was numerous, been unable to grow sufficient seedlings on their own premises to set the desired acreage. Under such circumstances

farmers are forced to plant fewer acres than intended or to meet the deficiency they are compelled to purchase plants which are frequently only obtainable from other states. This practice not only adds to the cost of production but increases the danger from introduced pests.

This bulletin is a report on observations covering the active period of the insect for eight seasons, the effects of weather and of different crops on their numbers, and the susceptibility of the fly to certain control measures. The present investigation was initiated in 1906 and has been continued, with interruptions, until the autumn of 1913. The control work during the early part of the study was directed mainly to perfecting the method of growing cabbage seedlings under cheesecloth, for the protection of young plants in districts devoted to the cultivation of late varieties of cabbage.[1] More recently the various remedies applicable to the protection of truck crops were investigated [2] and a brief announcement [3] was made regarding some points in the life history of the pest. This bulletin gives the progress of the investigation up to the present time.

HISTORICAL NOTES AND SYNONYMY.

HABITS AND GENERAL CHARACTERS OF THE ANTHOMYIDÆ.

The Anthomyidæ (*Anthos* flower and *muia* fly) have been so named from their habit of frequenting flowers of various plants, conspicuous among which are the *Umbelliferæ* and *Compositæ*. They are small to moderately large flies, often resembling the common house fly, and usually are non-metallic in color. The group is closely allied to the typical species of the family Muscidæ from which it was separated by Meigen in 1838. The Anthomyidæ are characterized by having the first posterior cell of the wing broadly open, the squamæ usually of considerable size, and the eyes of the male contiguous. In the larval stage the great majority of the species are vegetable feeders, either in living or decaying material. According to Williston[4] the larvæ of species of such genera as *Spilogaster*, *Hydrotæa*, *Hylemyia* and *Cœnosia* have been found in dung or manure; those of *Hydrotæa*, *Ophyra*, *Anthomyia*, *Homalomyia* and others in decaying vegetable material; those of *Hylemyia*, *Anthomyia*, *Homalomyia* in the

[1] N. Y. Exp. Sta. Buls. 301 and 334.
[2] N. Y. Exp. Sta. Bul. 382.
[3] *Jour. Econ. Ent.* 4:210–216, 1911.
[4] Williston, S. W. Manual of North American Diptera, p. 333, 1908.

nests of various hymenoptera, while the larvæ of various species of *Phorbia* (*Pegomyia*) feed upon the sound roots of onions, radishes and related crops.

SYNONYMY.

The adult of the cabbage maggot was described as *brassicæ* by Bouché[1] in 1833 and again more fully in 1834 and placed in the genus *Anthomyia*. Meigen[2] had described the species in 1826 under the name of *Anthomyia floralis* Fallen. Thus Meigen's description antedates that of Bouché's *brassicæ* several years, but as *floralis* is occupied in the same genus by *floralis* Fallen, Bouché's name has been accepted.

The insect was again described by Macquart[3] in 1835 under the name *Chortophila floccosa.* Zetterstedt[4] gave a description of the fly under the name of *Aricia floralis* Meig. non Fallen. In 1835 Harris[5] named the insect which he had reared from maggots working in radishes as *Anthomyia raphani* and published a description in 1841. Curtis[6] in 1843 determined the larvæ he found in cabbage roots as *Anthomyia radicum* L. Schiner,[7] in 1862, examined a Zetterstedt specimen of *Aricia floralis* Meig. non Fallen and placed it in the genus Anthomyia. Fitch,[8] although unable to separate the flies bred from different sources, treated them separately and retained the names *raphani* for the species infesting radish and *brassicæ* for the one attacking cabbage.

For many years the insect was recorded in literature under several names without much question as to the identity of the species. But in 1883 Meade[9] stated in his description of *floccosa* Macq. that it was probably a synonym of the *floralis* of Fallen and Meigen. In 1888 Stein[10] records *floccosa* Macq. as common in Saxony and also says it is synonymous with *floralis* Fall.; but in 1892 after an

[1] Naturgesch. d. Garten-Insekten, p. 131, 1833. Same 1834, p. 73.
[2] Syst. Beschr., V: 165, 1826.
[3] Hist. Nat. Dipt., II: 326, 1835.
[4] Dipt. Scand., IV, 1536.
[5] Harris, T. W. Cat. Animals of Mass., p. 80, 1835.
Harris, T. W. Ins. Inj. to Vegetation, p. 494, 1841.
[6] *Jour. Roy. Agr. Soc. of Eng.*, 4: 127–131.
Curtis, John. Farm Insects, p. 141, 1860.
[7] Fauna. Austr., 1: 646.
[8] Fitch, Asa, 11th N. Y. Rept., pp. 59–61 and pp. 40–43.
[9] R. H. Meade. *Ent. Mo. Mag.* 19: 214, 1883.
[10] Cornell Agr. Exp. Sta., Bul. 78, p. 575, 1894.

examination of type specimens concludes that *floralis* Fall. is distinct from *floccosa* Macq. This situation was interpreted by Slingerland to mean that *floccosa* Macq. was synonymous with the *floralis* of Meigen but not with the original types used by Fallen. The problem of identity was further simplified when both Meade and Stein, in reply to Slingerland, stated that *brassicæ* Bouché and *floccosa* Macquart were synonymous.

The cabbage maggot was for a long time known in Europe as *Phorbia floralis* and by systematic writers as *floccosa*, although a few writers recognized the name *brassicæ*. In this country the species found on cabbage was commonly regarded as *brassicæ*, and those attacking turnips and radishes as *radicum* and *raphani*. Economic workers in America noticed the similarity of the insects from these different sources and Fitch, Lintner, Cook and Fletcher all questioned the prevailing notions as to the distinction of the species; but to Slingerland is due the credit of clearing up the synonymy. By examination of type specimens and the literature of the species, he concluded that *brassicæ* and *raphani* were synonymous and that *radicum* [1] does not occur in this country.

Stein,[2] in his revision of the Anthomyidæ, placed *brassicæ* in the genus Chortophila, which name has been adopted by many economic writers in Europe. In the United States, *brassicæ* has been assigned by entomologists generally to either Phorbia or Pegomyia (Pegomya), but since Phorbia is synonymous with Chortophila and has the merit of priority, we have, at the suggestion of Aldrich,[3] discussed the species under the appellation of *Phorbia brassicæ*.

ECONOMIC IMPORTANCE.

The insect has been known on the Continent of Europe since it was described by Bouché [4] in 1833. There are a few accounts of injury by the species in Germany, Switzerland and the Netherlands, but it has received most attention by the economic writers of Norway and Sweden and of Finland. In 1899 Sven Lampa [5] reported that fourteen acres of turnips near Orbyhus in Uppland (Sweden), were

[1] Since the publication of Slingerland's account, *radicum* has been reported by various writers to occur in the United States.
[2] Bezzi and Stein, Katalog der Paläarktischen Dipteren, 3:710, 1907.
[3] Letter from Dr. J. M. Aldrich, dated Feb. 28, 1916.
[4] Bouché, P. F., Naturgesch. d. Garten-Insekten, p. 74, 1834.
[5] Uppsatser Praktisk Entomologi, pp. 47–49, 1899.

practically destroyed. Schöyen[1] of Christiana, Norway, has mentioned the injury of the insect in a number of his annual reports, particularly those of 1899, 1900, 1902 and 1904. Reuter[2] of Helsingfors, Finland, has referred to the destructive work of the insect almost every year during the period of 1897 to 1909. In 1897[3] he records injury to rape in the Island of Gotland, that amounted to many thousands of dollars. He states that rape is not grown in Finland but that the insects attack other plants and that they are very detrimental to the seed-growing industry. One of Reuter's correspondents, Dr. Grotenfelt[4] of Mustiala, reports serious injury to young cabbage plants. He noticed that the destruction was greatest on light or sandy soil. Reuter[5] received reports in 1900 of injury to cabbage and cauliflower in the vicinity of Esbo, and states that in 1904[6] the insect attracted less attention than in previous years.

In England the species has long been regarded as of much importance. According to Slingerland[7] the insect was mentioned by Major in 1829 as the cauliflower fly. Curtis stated in 1841 that it often destroyed whole fields of cabbage. The insect is discussed many times by Miss Ormerod[8] in her annual reports, and more recently by Whitehead and Theobald.[9] Judging by their accounts and that of Carpenter[10] of Ireland, the insect probably occurs in the British Islands wherever these vegetables are extensively grown.

The entomological literature of the Dominion of Canada is especially rich in references to this species. Fletcher has mentioned the insect in his annual reports almost every year from 1885 to 1906 and more recently it has been a subject for discussion by Bethune and Hewitt. As early as 1885 Fletcher[11] reports serious injury in all parts of Canada, from Nova Scotia to Vancouver Island. Mr. R. Brodie[12] of Montreal, one of Fletcher's correspondents, says, "The cabbage

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[1] Beretning om Skadeinsekter og Plantesygdommen.
[2] Skad. Upp. i Finland, 1897–1909.
[3] Skad. Upp. i Finland, p. 51, 1897.
[4] Skad. Upp. i Finland, p. 35, 1899.
[5] Skad. Upp. i Finland, p. 29, 1900.
[6] Skad. Upp. i Finland, p. 5, 1904.
[7] Cornell Exp. Sta. Bul. 78, p. 482, 1894.
[8] Ormerod, E. A., Rept., p. 8, 1881; p 10, 1882; p. 146, 1893.
[9] Economic Zoology, 1st Rept., p. 34; 2nd Rept., p. 67.
[10] *Jour. Dept. Agr.*, 3:109, 1902.
[11] Rept. Exp. Farms, Ottawa, p. 6, 1885.
[12] Rept. Exp. Farms, Ottawa, p. 22, 1887.

maggot has been very destructive to our cabbages and cauliflowers in this neighborhood these past few years, but especially last season. In 1885 I planted two acres of early cabbage and lost about half of them by the maggots." Mr. Lang of Barrie, Ontario, makes a similar complaint. In his report for 1890 Fletcher [1] says the insect was particularly injurious during that season, and during the following year records it as the most destructive species. In 1898 outbreaks are mentioned near Olds, Alberta, and along the St. Lawrence in the Province of Quebec. He further states that "root maggots did much harm throughout the season". In 1900[2] the insects were unusually scarce at Nappan, Nova Scotia, but at other points in Nova Scotia, New Brunswick and Prince Edward Island they were very destructive. In his report for the same year [3] it is stated that, "The root maggots caused great havoc in many places among cauliflowers and early cabbages." P. B. Gregson[4] in 1901 mentions injury from the maggots that occurred at many points in Alberta, particularly at Edmonton, while Fletcher[5] in his report states that they were decidedly more abundant than usual in some places in western Assiniboia and around Calgary, in Alberta, and also on the coast of British Columbia. The latter again stated in 1903,[6] "The cabbage or radish maggot did much injury to turnips as well as cabbage and cauliflowers in gardens. It was, however, irregular in its occurrence, doing much harm in one place, while in another very close to it, it hardly appeared at all." The insect was mentioned by Blair [7] in 1904 and by Fletcher [8] in 1905. This latter report is especially interesting. "The onion and cabbage maggots which for the last few years have been so excessively destructive, during the past season were hardly noticeable in many localities where in previous years they had made a clean sweep of almost everything." The following season he states that they had been less destructive than has been the case for some years. Bethune [9] reported in 1906 a serious infestation at Markdale, Ontario. The insect was reported

[1] Rept. Exp. Farms, Ottawa, pp. 161–165, 1890.
[2] Rept. Exp. Farms, Ottawa, p. 238, 1900.
[3] 31st Ann. Rept. Ent. Soc. of Ont., p. 70, 1900.
[4] 32nd Ann. Rept. Ent. Soc. of Ont., p. 119, 1901.
[5] Rept. Exp. Farms, Ottawa, p. 230, 1901.
[6] 34th Ann. Rept. of Ent. Soc. Ont., p. 65, 1903.
[7] Rept. Exp. Farms Ottawa, p. 362, 1904.
[8] 36th Ann. Rept. Ent. Soc. Ont., p. 86, 1905.
[9] 37th Ann. Rept. Ent. Soc. Ont., p. 49, 1906.

again by Hewitt [1] as injurious during 1910 and 1911. In the former report he says, "From year to year the attacks of these insects appear to assume greater proportions."

The insect was first recorded in Massachusetts in 1835 by Dr. Harris [2] and since has been frequently reported as occurring in destructive numbers. In the trucking regions near Boston it has been very difficult in some seasons to grow early cabbage. Packard [3] mentions, in his report for 1877, that he had known the insect in Maine more than twenty years. It is again listed by Miss Patch [4] in 1907. Weed [5] describes a serious outbreak in New Hampshire as follows: "During the season of 1903 there was a very extraordinary attack throughout New England of the various root maggots of the genus *Anthomyia*. Cabbages, cauliflowers and onions were infested to an extent that completely ruined the crop for hundreds of growers." Waugh [6] mentions the occurrence of the pest in Vermont in 1897 and says that the insect had been known ten years before. Britton [7] mentions a case of serious injury to three acres of cabbage in Orange county, Conn., in May, 1895. In describing the injury by cabbage and onion maggots Smith [8] of New Jersey says that these plants are more or less damaged every year. "The injury may not be equally severe two successive years . . . or there may be a series of bad seasons. During the past few years, however, the injury has been serious in many sections of the State, the loss on one farm alone in Cumberland county amounting, in 1906, to $1,000 or over, while in many other places from one-half to one-fourth of the crop was destroyed." The insect is evidently of much importance in Minnesota, for Washburn [9] in his Diptera of Minnesota remarks, "The larvæ of this fly caused a loss of thousands of dollars to market gardeners in this state alone."

The insect has been known in New York State for many years. Its injuries are especially noticeable in the trucking regions about the large cities and in localities that are devoted to the production

[1] Rept. Exp. Farms, Ottawa, p. 229, 1910; p. 229, 1911
[2] Cat. of Animals and Plants of Mass., p. 80, 1835
[3] U. S. Geological Survey Rept. for 1877, p. 762
[4] Maine Exp. Sta., Bul. 148, p. 282.
[5] N. H. Exp. Sta., Bul. 115, p. 174.
[6] Vt. Exp. Sta. Rept., pp. 116-9, 1896-1897
[7] Conn. St. Exp. Sta. Rept. 1895, p. 207
[8] N. J. Exp. Sta. Bul. 200, pp. 3-27.
[9] Minn. Exp. Sta. Bul., 93, p. 122.

of late cabbage. In some communities the gardeners have found that it does not pay to grow radishes, except some early varieties. Early cabbage, cauliflower, and seedlings grown for late cabbage are also very susceptible. The insect is a constant source of annoyance to persons desiring to grow these vegetables in kitchen gardens as well as a great handicap to the market gardener and cabbage grower.

In conclusion, the insect varies in numbers from year to year, much the same as many native pests. There are often periods covering several seasons when the injuries are marked, which may be followed by a number of years during which the insects are difficult to find or the numbers are so small as to be unimportant. Not only do the injuries vary during a period of years, but frequently damages by the pest are unequally distributed in the same community.

DISTRIBUTION.

As indicated in the previous chapter, the insect is widely distributed throughout the British Isles and northern Europe, including the Scandinavian peninsula, Holland, Switzerland, Germany and Austria. It apparently has not attracted attention in France and Italy. Chittenden [1] gives, as the distribution in North America, Canada and the northern tier of states in the United States. The insect is also known to be injurious in Pennsylvania, Ohio and northern Illinois. It has been reported in Maryland, Virginia, Mississippi, Florida, South Carolina, Georgia, Alabama and Colorado.

An examination of the map shows that injurious outbreaks of this insect have not been reported south of parallel 40° N. in North America nor south of parallel 50° in Europe.

HOST PLANTS OF INSECT.

The cultivated plants, cabbage, cauliflower (*Brassica oleracea*), radish (*Raphanus sativus*), turnip (*Brassica rapa*), rutabaga or swedes (*Brassica campestris*), and stock (*Matthiola*) are mentioned by Slingerland as food plants listed in European literature. The two mustard-like weeds, common winter cress (*Barbarea vulgaris*) and the hedge mustard (*Sisymbrium officinale*) are also recorded as susceptible to attack. In our work we have found maggots attacking

[1] Chittenden, F. H., Insects Injurious to Vegetables, p. 132, 1907.

all cruciferous crops cultivated in the region about Geneva as well as wild mustard. In the early summer the larvæ have often been collected from the roots of wild or hedge mustard, which occurs in great abundance in this region while on Long Island the creatures have been observed in the roots of white mustard (*Brassica alba*, Plate XLIII, fig. 2). Shepherd's purse (*Capsella bursa-pastoris*) and winter cress, both very common weeds in this area of the State, have appeared so far to be immune to attacks by the insect.

ORIGIN.

Slingerland[1] states, "Like its food plants, this insect is doubtless of European origin." Then after giving a full account of the early history of the insect in North America, he concludes, "Thus the pest was introduced into this country from Europe early in the present century, perhaps first appearing in Massachusetts, from whence it gradually spread north, west, and south into the neighboring states." Slingerland seems to have arrived at the conclusion that the insect had been introduced from Europe, because its food plants were of European origin, and that the insect had been reported first at Boston from whence it spread westward.

It has been more than twenty years since this statement was made, and the insect has not yet been found injurious to any plant not of European or Asiatic origin. The wild cabbage, *Brassica oleracea* var. *sylvestris*, which is looked upon as the prototype of the large group of plants to which the term cabbage is now applied, can be found growing wild on the western shores of Europe and in England. According to Britton and Brown[2] the various weeds of the mustard family upon which the insect is known to feed and many others upon which the insect has not been reported, have been naturalized from Europe. Also the statement is made that many of these mustard-like weeds have been found about our principal seaports growing in soil that has been used as ballast. The suggestion is that the transportation of earth in the form of ballast has been the means of introducing the seeds of certain foreign plants into this country. The danger from this source would depend upon where the soil was taken. But it is safe to conclude that if the seeds of

[1] Cornell Exp. Sta. Bul. 78, p. 482, 1894.

[2] Britton and Brown, Illustrated Flora of the Northern States and Canada, 2:116, 1897.

many varieties of mustards have been imported in ballast as Britton and Brown assert, large numbers of puparia of the cabbage maggot have been brought to our shores in the same way.

If we take into consideration the number of weeks required for ships to cross the Atlantic about 1830 it would not seem possible for the insect to have been been brought over in the egg or adult stages. Although infested turnips used for food on the ship-board might have carried larvæ, the probability of the species having been transported in the larval stage is rather remote. On the other hand if ballast were taken from soil at almost any point in Holland, Denmark or Sweden in which these mustard-like weeds were growing, it would be very likely to contain puparia and the conditions for introducing the insect would be ideal.

BIOLOGY OF THE INSECT.

DESCRIPTIONS OF LIFE STAGES.

Egg.— (Plate XL, fig. 1). The chorion is white, glistening and marked with irregular longitudinal furrows. The egg is .34 mm. in diameter and 1.1 mm. long. The outer end, that first extruded from the ovipositor, is bluntly rounded, while the opposite end is more conical and flattened at the apex. Extending along the dorsum from this flattened area is a depression that is formed by two sutures reaching about two-thirds the length of the egg. The chorion breaks along these sutures when the larva emerges.

Larva, First instar.— The larva is .35 mm. in diameter by 1.5 mm. long. It is cylindrical and tapers anteriorly. The tubercles adorning the caudal segment are similar to those later described for the other stages, though in some specimens the bifid tubercle appears as two tubercles. There are no anterior spiracles present, which differentiates this from the later stages.

Second instar.— The size varies slightly, but the individuals average about .8 mm. in diameter and 3.75 mm. in length. The anterior spiracular process contains from eight to twelve divisions. The posterior spiracular process has only two slits which easily distinguish this from the third instar.

Third instar.— (Plate XL, fig. 2). The size varies from 1 mm. to 2 mm. in diameter and from 2.5 to 8 mm. in length. It is white, fleshy, at first cylindrical and tapering anteriorly, but toward the

end of the feeding period the middle segments become much enlarged. The rear of the caudal segment is flat or slightly concave and obliquely truncate. This segment is ornamented with seven pairs of fleshy tubercles, one pair of which protrudes in the region of the anus, the others are arranged on or near the rear margin of the posterior segment. The two pairs of tubercles that protrude from the lower margin are the most conspicuous, both because of their position and larger size. Each tubercle of the central pair is slightly notched, so that it is two-pointed. This character distinguishes *brassicæ* from other species found about cruciferous plants. The rear spiracles, which are extensions of the longitudinal tracheal trunks, protrude from the center of the flattened area. They are yellow in color and slightly knob-shaped, and each contains three slit-like openings. These openings are guarded by irregular dendritic processes. In the head region a pair of black, opaque hooks protrude from the buccal opening. In close proximity to this opening on the surface of the cheek are two pairs of tubercles. The anterior spiracular processes protrude laterally from the sutures of the first and second anterior segment. This process is fan-shaped and contains ten to fourteen papilliform tubules. Before the transformation of the larva to the pupa the bifid tubercles mentioned above shrink in size and change to an opaque black. This change may occur either several days or only a few hours before pupation.

Puparium.— (Plate XL, fig. 4). Elongate-ovate, bluntly rounded at the ends. The outer protective covering of the pupa is formed by the hardening and contraction of the integument of the third instar, and contains some of the characteristic structures of the larva. The two pairs of posterior tubercles, one pair of which is bifid, and which serve to distinguish the larva, are usually evident, though smaller than in the larva, due to the shrinking and hardening of the chitin. The anterior spiracular process which in the larva protrudes posterior to the first segment is located at the anterior end of the puparium. The large individuals measure 2.3 mm. in diameter by 6.5 mm. long and the small specimens 1.05 mm. in diameter by 3.52 mm. long. These are the measurements of the puparia of the overfed and the underfed larvæ. The normal individuals measure about 2 mm. by 5.5 mm.

Adult, male.— (Plate XXXIX, fig. 1). Very bristly, color generally dark with gray markings. The compound eyes occupy most of the

surface of the head and are contiguous. Face silvery gray. Antennæ black, and three-jointed. Basal segment small; third segment largest and bears a two-jointed pubescent bristle. Thorax ash gray in color with three distinct longitudinal lines on dorsum. Squamæ large. The hind body shining dark gray, rather small, ellipitical, tapering and bluntly rounded at the apex when viewed from above and slightly clavate as seen from a lateral view. Abdomen ornamented with bristles which are of two sizes. The large bristles occur in rows near the rear margin of the segments, while the others, which are more numerous, are irregularly distributed. Wing veins brownish and second posterior cell broadly open. Legs black and bristly, with a tuft of short bristles at the base of the posterior femur. This tuft of bristles serves to separate the males of this species from males of closely allied forms.

Adult, female.— (Plate XXXIX, fig. 2). The female is much lighter in color than the male. The body and legs are ash gray with a tinge of brown. Eyes dichoptic. Dorsum of thorax striped as in the male, but less distinct. Abdomen slightly top-shaped, conical toward the apex, and less bristled than the male. The tuft of bristles at the base of the posterior femur, which serves to distinguish the male, is absent in the female.

The adults average about 6 mm. in length, though they vary to the same degree as the puparia.

LIFE HISTORY AND HABITS.

DURATION OF LARVAL PERIOD.

Until recently, data bearing on the length of the larval period have been meager. Bouché stated that the larval stage lasts three to four weeks, and a number of later writers have expressed similar views. Washburn gives twenty to twenty-one days as the length of the larval period.[1] As shown previously,[2] this time was found to be eighteen to twenty days when the larvæ were reared in the laboratory. Of more interest and of considerable more importance is the time actually required for the larva to mature in the field. During the years of 1908, '09, and '10, the eggs were being deposited about cabbage plants in large numbers, from about May 20th to

[1] Minn. Exp. Sta. Bul. 100, p. 6. 1906
[2] *Jour. Econ. Ent.*, 4:214. 1911.

June 4th. During these years first brood larvæ were found in large numbers from June 10th to June 25th. It is thus seen that in the field the larvæ of the first brood require about twenty-one days to mature.

While both laboratory and field observations indicate that under normal conditions the larval stage lasts about three weeks, a large amount of data has been accumulated to show that the extent of this period may be materially altered. When disturbed or in the absence of food, larvæ have been known to pupate when they had reached only half size. It is thought that lack of sufficient moisture will also stimulate the larva to pupate. Several laboratory tests planned to determine the effect of moisture failed to yield results, because the larvæ would either die or pupate when the food became dry. It is a common experience on removing infested radishes from the soil to have the larvæ quit the plants and pupate as soon as the bulbs become shriveled. Under such circumstances there is usually much variation in the sizes of the puparia.

SELECTION OF HOST PLANTS.

There seems to be a general impression among writers on this subject that some plants are more liable to attack than others. Cook observed in 1888 that radishes were more attractive to the insect for purpose of oviposition than cabbage, and suggested the use of radishes as a trap crop. Hulst also states that cauliflower is preferred to either cabbage or radish. We have frequently noticed that where rows of cauliflower alternated with rows of cabbage, the former plants sustained greater damage. A number of cabbage growers in this community have, for several years, mixed radish seed with cabbage seed in growing their seedlings. Some of these beds have been very carefully examined and it appears that radishes generally contain more maggots than cabbages, though cabbage seedlings have always shown evidence of maggot injury and in one instance practically all of the cabbage seedlings were ruined. During three seasons cruciferous plants grown especially to determine their relative susceptibilities have been systematically examined at various times during the growing period. Also numerous inspections have been made of all the wild and cultivated cruciferæ in this locality. The general conclusion of these studies is that, while in some instances more eggs have been deposited about one variety than another,

tenderness of growth or succulency has much more to do with the degree of infestation than the variety or species of plant. In the early part of the summer maggots can be found about the roots of all varieties of cabbage seedlings and about wild mustard, while later in the summer when adults are present in considerable numbers it has been difficult to find the larvæ about either cabbage or mustard.

SEASONAL SUSCEPTIBILITY OF CABBAGE TO INJURY.

In the locality about Geneva, N. Y., where late varieties of cabbage are extensively grown, we have never been able to find during the summer any fields that were being injured by root-maggots. As just stated, these insects are always present in the spring, injuring cabbage seedlings, cauliflower, radish and other cruciferous plants and also in the fall attacking turnips, cabbage stumps, etc. Not only are injuries absent during July and August, but it is difficult to find the work of the insects on roots of the different varieties of cabbages grown in this region at the time the crop is harvested.

There are two classes of varieties of cabbage grown in this community, one locally called late cabbage, including such varieties as Holland Danish, Red Danish and Danish Ball-head, the sets being planted during early July and the crops harvested about the first of November. The other, commonly known as early cabbage, including such varieties as All Head Early and All Seasons, is planted from the first to the fifteenth of June and matures during the first part of September. The early varieties are grown for immediate consumption and for sale to kraut factories, while the late kinds are stored for winter use.

During the autumns of 1910, 1911 and 1912 numerous inspections of the fields in the vicinity of Geneva, N. Y., were made to learn particularly the extent to which cabbage stumps serve as breeding places for the pest. After cabbages are cut it is a common practice in New York to allow the stumps to remain undisturbed until the following spring. With the removal of the crop in the autumn these stumps put forth numerous shoots which continue to grow till the appearance of very cold weather. The adventitious buds or sprouts (Plate VI) are very attractive to the adults of this insect, and numerous eggs are deposited on the stalk at the bases of the buds, so that before the appearance of cold weather the sprouted stumps may be thoroughly infested with maggots. Since the late cabbage

is not taken from the fields until cold weather and after the period of oviposition has past it is practically free from injury during the autumn.

It is thus seen that during ordinary years the cabbage crop is only subject to injury by root-maggots during the spring months. The observations indicate also that the crop remnants of the varieties of cabbage that mature in September constitute the chief breeding places for the cabbage maggot in this locality during the autumn.

INJURIES BY MAGGOTS TO CABBAGE ROOTS.

When the root of the seedling cabbage or cauliflower is attacked, the young larva directs its activities at first to the cortex of the stem just below the surface of the soil. Later the entire stalk may be consumed or the larva may confine its work to a more or less irregular groove. When the seed bed is badly injured it is usual to find seedlings in which only a few withered leaves and the outer epidermal structures of the stalk remain, the larvæ having mined the interior of the stalk and the largest petioles after exhausting the food at the root (Plate XLII). The laceration of the root by the larva is often accompanied by decay of the injured parts. When the body of a radish or turnip is attacked, the larvæ are most often found in hidden tunnels in the cortex, though the tunnels frequently penetrate more deeply (Plate XLIII). Sometimes these channels are mere grooves, the epidermis having been destroyed. The channels made by the larvæ in the aerial part of a cabbage stalk are nearly always found in the cortex and are hidden by the thin outer bark (Plate XLIV).

The size of the channels is about the same as the girth of the maggot. They extend in no definite direction, occasionally being straight, but more often winding or zigzag. The newly made tunnels are clean, but later they frequently become browned and discolored, due to the decay of the exposed tissues.

PUPARIUM.

As shown later, the length of the pupal period depends upon the conditions surrounding the puparium. The pupa stage lasts, ordinarily, from twelve to eighteen days for most individuals, while a few pupæ require two to three months. The brood that hibernates remains in this stage for five to eight months, and an occasional

pupa of the hibernating brood may require eight or ten months to develop.

The puparium of the cabbage maggot is found in the soil in close proximity to the roots of cruciferous plants. In examining infested cabbage seed-beds during June for first brood puparia, the observation has frequently been made that at least ninety per ct. of the individuals are found within three inches of the injured plant and in the first three inches of soil. A great many specimens can be found within an inch of the plant and rarely a puparium may be found in the injured seedling. This is more likely to occur in plants having a tuber-like root, such as turnips and radishes. In autumn the hibernating brood occurs at a slightly greater distance from the injured root than the spring brood. At this season the puparia are fiequently found at a depth of four inches and at a distance of five or six inches from the plant. When the aerial parts of the plant become infested, such as sprouted cabbage stumps and cabbages that have put forth second growth, a small percentage of the larvæ pupate in the upper part of the plant.

The tendency of the larva to migrate from the infested plant has a very important bearing on the numbers that would reach maturity. This is especially true when the insect infests root crops grown for stock feed. If the larvæ were to pupate in the turnips or Swedes grown to be used as succulent feed during the winter, they would largely be destroyed.

PERIOD OF EMERGENCE OF ADULTS OF THE SPRING BROOD.

There are many observations on record as to the time the first adults of *P. brassicæ* appear in the spring, but apparently no data have been collected as to the number of days required for the entire brood to emerge. To secure information on this point an arrangement was made with Mr. O. W. Winburn, Geneva, to place cloth screens over an infested stump field to entrap the flies as they emerged from the soil. The field selected for this purpose was one that had been planted to early cabbage the year previous, the crop having been taken during September and the stumps permitted to sprout. Some of these stumps had become badly infested with maggots before cold weather stopped their growth. The ground for the experiment was divided into three plats, one of which was not cultivated, the other two being plowed six and nine

inches respectively. Tight cheesecloth frames six by eighteen feet were erected over each plat and the flies collected as shown in Table I.

TABLE I.— A RECORD OF THE EMERGENCE OF CABBAGE MAGGOT FLIES AT SENECA CASTLE DURING 1911.

DATE OF COLLECTION.	Plowed 6 inches.	Plowed 9 inches.	Not plowed.	Total.
April 29	Screened	....	....	....
May 4	....	Screened	Screened	....
May 9	5	....	7	12
May 15	6	....	2	8
May 19	1	14	3	18
May 27	21	....	1	22
June 2	14	....	....	14
June 7	3	....	....	3
June 14	2	....	2	4
June 14	Screens removed	....	Total....	81

Attention is directed to the fact that the adults continued to emerge over a considerable period; in this case, from May 9th to June 14th or thirty-six days. The number collected from each of these plats is too small to indicate the effect of cultivation upon their emergence.

DEPTH OF SOIL THROUGH WHICH ADULTS EMERGE.

Washburn [1] reports an experiment in which pupæ of *P. brassicæ* were buried out of doors at depths of 1, 2, 3, 4, 5 and 6 inches. No adults emerged from the lots buried one and six inches respectively in the soil and he states, "It would seem that the flies were not able to penetrate through six inches of soil under conditions as nearly like outside conditions as possible," Card and Stene [2] found *Rhagoletis pomonella* able to emerge from a depth of six inches, though normally larvæ of this species pupate in the first inch of the soil. Stiles and Gardner,[3] while working with *Musca domestica*, had thirty-seven flies emerge from puparia buried in sand to a depth of forty-eight inches. These experiments show that some diptera are adapted to pushing their way through a considerable depth of soil.

[1] Minn. Exp. Sta. Bul., 112, p. 204.
[2] Md. Exp. Sta. Ann. Rpt. 1904, p. 192.
[3] U. S. Pub. Health & Mar. Hosp. Serv. *Public Health Repts.* 15:1829. 1910

On June 23, 1906, several pots were prepared and fourteen puparia of *P. brassicæ* were planted in each, ranging in depths from two to twelve inches. By August 16th adults had emerged as follows:

Depth of Puparia in Soil.	Number of Adults Emerging.
2 inches	1
4 inches	1
6 inches	0
8 inches	2
10 inches	5
12 inches	3

The soil used in this case was a clay loam, which was only slightly compacted. The pots were kept in the laboratory. The fact that some flies were able to emerge from such depths, even under the most favorable circumstances, would certainly discourage any efforts to control the insect by cultivation which had as its object deep burial of the puparia in the soil.

DISPERSION OF ADULTS.

Winds play an important part in the distribution of insects. Popenoe [1] in his work with the potato beetle along the east shore of Virginia observed that an off-shore wind carried great numbers of the hibernating individuals out to sea where they perished, the beach often being covered with windrows of the dead beetles. Hartzell [2] reports that large numbers of rose chafers were washed up on the shore of Lake Erie, near Westfield; and in the summer of 1906, we found dead May beetles along the northeast beach of Seneca Lake. Similar observations on other species of insects have been recorded in literature.

In our studies about Geneva and Seneca Castle, N. Y., it appears that cabbage is the chief breeding place of the root maggot and that a majority of the insects hibernate in fields where the stumps are left standing, but in most seasons the injury, when present, is so general that it is not possible to learn whether or not the injury to the seed-bed is influenced by being located near a stump field. Here cabbage is extensively grown and our observations indicate that the insect, especially when abundant, becomes pretty thoroughly distributed. Frequently the space between cabbage fields is often not much greater than the fields themselves, so that only a small

[1] U. S. D. A. Ent. Bul. 82, p. 1.
[2] From records of the N. Y. Agricultural Experiment Station.

amount of dispersion is necessary. In years when the adults are not so numerous or in other localities that are not so exclusively devoted to this crop, the insects are likely to be more abundant in close proximity to the fields than elsewhere. Also, it has been observed in some years that seedlings in cabbage-growing localities have been pretty generally destroyed, while on farms a few miles distant the seed-beds were in excellent condition.

FEEDING AND OTHER HABITS OF ADULTS.

The difficulty of breeding *P. brassicæ* and other diptera has been mentioned by several workers. Slingerland[1] in his study of this species was unable to obtain eggs, though his cages contained hundreds of adults. Washburn,[2] however, finds that adults which have matured in the field will oviposit in cages, but he does not state their egg-laying capacity. Hewitt[3] in his investigation of *Musca domestica* speaks of certain difficulties in rearing this insect.

The adults used in our efforts to breed *P. brassicæ* were mostly those that had emerged in cages in the laboratory, and some fresh-looking individuals captured at large. In addition to supplying them with water and some cruciferous plants for purposes of feeding there were also furnished banana, sugar water and blossoms of the common weeds in this community, including wild mustard (*Sisymbrium officinale*), wild carrot (*Daucus carota*) and the milk-weed (*Asclepias* sp.). The adults were seen to visit the blossoms and to feed greedily upon the sweetened mixture and half decayed banana. Usually they were quick to detect the presence of dilute molasses or sugar syrup when a drop was placed in the cage, often locating the food in a few seconds. When adults were put in cages in the laboratory without food they lived only two or at the most, three days, while with food and water regularly supplied, the length of life ranged from two to four weeks; and in one instance a female lived forty-eight days in a lantern globe. This individual emerged in the laboratory and was first observed April 18th. For the last two weeks of its life the fly was not very active, and for three or four days before it died was hardly able to crawl. The posterior third of both wings had been worn away and one of the tibiæ was lost. In the abdomen were found thirteen full-sized eggs, the chorion of which

[1] Cornell Exp. Sta., Bul. 78, p. 513.
[2] Minn. Exp. Sta. Bul. 100, p. 5.
[3] Hewitt, C. Gordon. The House Fly, p. 64. 1910.

appeared mucilaginous and somewhat smooth in contrast to the usual clean-furrowed ova.

The facts brought out by the cage work has been the fondness of the adult for sweetened water and the necessity for food and moisture for its sustenance.

In the field various species of *Anthomyidæ* are present in this latitude from May until October. They are conspicuous during the latter part of May and June, and the species affecting cabbage can be found about fruit blossoms and flowers of certain weeds. Frequently while apples are in bloom adults have been taken with pollen clinging to the legs and chætæ. After the period of fruit blossoming the flies are found in abundance about wild mustard blossoms. Later in the season the adults become scarce and usually during August are difficult to find, though they reappear in September. Observations on the relative abundance of adults during the different summer months are presented in chronological order in Table IV. The activities of the flies during the day are influenced to a marked degree by the weather. During early morning and on cool or windy days, the adults remain in hiding and may usually be taken by sweeping mustard or cabbage. At such times they have been frequently seen on the under side of the plants. During the warmest part of a cool day adults of this and other species have been collected along warm, sunny paths and about protected situations.

Low temperatures, of course, reduce the number of eggs deposited;[1] but windy weather, during which the adults remain in hiding, does not act upon the insects in the same manner. During the occurrence of strong winds, adult females have been found in chinks in the soil, and in crevices about cabbage plants. The swaying of the seedling after a rain pushes back the earth at the surface, forming a small pocket by the stalk. This seems to be a favorite retreat during a strong wind, and large numbers of eggs have been found at the lower extremity of this pocket in the afternoons of windy days. Freshly plowed or cultivated soil attracts the flies. They have been observed many times in recently turned furrows where they appear to feed.

Our observations indicate that during periods favorable for oviposition the females are found on the soil and near cruciferous plants, while the males confine themselves largely to the foliage of weeds and shrubs. On May 24, 1909, while inspecting some

[1] *Jour. Econ. Ent.* 4:211.

cabbage seedlings in a truck garden near Waterloo, N. Y., a number of males were noticed on onion tops, and nearby, on freshly stirred soil from which onions had recently been taken, a number of females. Although the flies were closely observed for some time, they were seen only to walk over the moist soil, occasionally stopping as if to lap moisture. The males appeared to bask in the sun, and remained quiet except for rubbing together the hind tarsi. This habit of the males of resting on shrubbery while the females are on the ground feeding or ovipositing has since been observed many times. Apparently they choose no special kind or size of plant, and in addition to weeds they have been taken on leaves of young elm, wild blackberry, strawberry, grape, aster and wild mustard.

APPEARANCE OF ADULTS IN RELATION TO THE BLOSSOMING OF FRUITS.

During eight seasons this insect has been under our observation, the first of the adults to emerge in the spring have appeared during the first two weeks of May, the actual time of appearance depending somewhat on the weather. The period of the first appearance of the flies as compared with the blossoming of our common fruits is shown in Table II.

TABLE II.— THE APPEARANCE OF ADULTS OF *P. brassicæ* AS COMPARED WITH THE BLOOMING TIME [1] OF CHERRY, APPLE AND PEAR.
(Data for Geneva, N. Y., for six years.)

	1907.	1908.	1909.	1910.	1911.	1913.
Adults appearing	May 16.	May 12.	May 13.	May 12.[2]	May 6.	May 1.
FRUIT BLOOMING:						
Cherry, Windsor....	May 15	May 12	May 13	Apr. 18	May 5	Apr. 26
Cherry, Montmorency............	May 18	May 18	May 18	May 1	May 11	May 2
Apple, R. I. Greening..............	May 31	May 23	May 27	May 9	May 18	May 4
Pear, Bartlett......	May 24	May 19	May 19	Apr. 30	May 13	May 1

[1] The blossoming time of fruits was kindly supplied by O. M. Taylor of this Station.

[2] During April of 1910 the weather was unusually warm. This is indicated by date at which the Windsor cherry bloomed that year. On April 29th flies were present about cabbage seed beds at Geneva, and some anthomyids were taken. Although these individuals could not be definitely identified as *P. brassicæ*, it is very probable that this species was present in small numbers. The weather turned cool immediately following April 29th and no more collections were made until May 12th when the identity of the insect was established.

Two interesting facts are suggested by this table: First, abnormal seasons affect the emergence of the adults and the blooming of tree fruits in much the same way; and second, the flies appear about the same time that the Windsor cherry is in bloom.

INTERVAL AFTER EMERGENCE OF ADULT BEFORE EGG DEPOSITION.

Our field observations have yielded no definite information on the extent of the preoviposition period except that eggs have been found either the first day adults were observed in the spring, or within the next two or three days. Since adults that emerged in captivity have not been induced to oviposit in cages any data secured in breeding-cage work is open to question. Notwithstanding this fact, numerous dissections were made both of females that emerged in cages and of individuals captured at large. In Table III are shown the measurements of the ova of adults that emerged in cages. These adults had been fed upon sugar water and egg albumen. The data show that the eggs attained full size in about seven days, even when the insects were in captivity. It is believed that during favorable weather the adults would mature even sooner in the open and would normally oviposit in from three to five days after emergence.

TABLE III.— MEASUREMENTS OF OVA IN THE OVIDUCTS OF ADULTS OF *P. brassicæ.*

POSITION OF EGGS IN IN OVIDUCT.	Adult just emerged.	Adult emerged 3 days.	Adult emerged 7 days.	Adult emerged 14 days.
Largest ova (1)........	190 x 240 microns	180 x 270 microns.	220 x 960 microns eggs apparently mature.	Ova mature.
Ova next to above (2)..	90 x 100 microns.	....	190 x 240 microns	210 x 360 microns.
Ova next to above (3)..	....	....	110 x 110 microns.	120 x 120 microns.
Ova next to above (4)..	....	....	100 x 100 microns.	80 x 80 microns.
Ova next to above (5)..	....	....	....	60 x 60 microns.

Second brood.— The emergence of the second brood during the same season was well defined by our collections from a plowing experiment.[1] These data show that the majority of the adults appeared between June 25th and July 3rd, though they continued to emerge during the rest of the month.

Third brood.— The adults were collected as in the previous brood, as they emerged from a bed planted to turnips and cabbage. In this case the collections indicate that the majority emerged between August 26th and Sept. 4th, though, as in the second brood, the total period of emergence lasted four or five weeks.

Broods observed during 1910: *First brood.*— A few anthomyids were collected in the latter part of April and though not definitely identified, adults of *P. brassicæ* were undoubtedly present at that

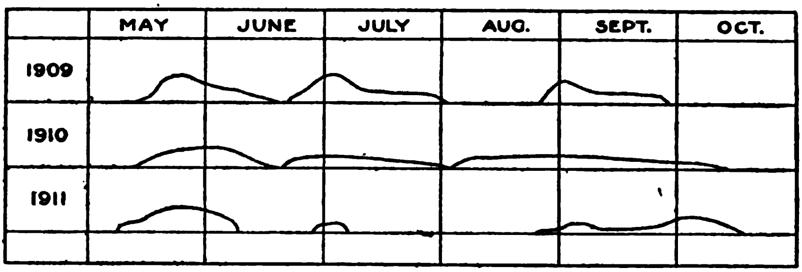

FIG. 12.— DIAGRAM SHOWING NUMBER OF BROODS AND PERIODS OF APPEARANCE ABOUT GENEVA, N. Y., DURING 1909, 1910 AND 1911.

time. Specimens of this species were abundant in the field from May 16th to June 9th.

Second brood.— Adults emerged almost daily from June 21st to August 2nd in outside breeding cages. Our records show that the numbers were greater between June 30th and July 8th than at any other time during this period. As the flies were all reared from eggs and pupæ of the first brood there is no doubt as to which brood these particular adults belong.

Third brood.— During this season adults were abundant in the field from August 3rd to October 3rd. A few were observed until October 14th. Certainly these were mostly third-brood flies, though the possibility of a partial fourth brood during this period is evident.

[1] *Jour. Econ. Ent.* 4:211.

Broods observed during 1911: *First brood.*— Adults were collected as they emerged from a cabbage-stump field, the period lasting from May 9th to June 14th. Adults were observed in the field three days prior to the first date and they were numerous in the field about June 6th.

Second brood.— Puparia secured from a sandy soil near Rochester produced flies in large numbers from June 9th to 16th. A small percentage of the puparia from this locality produced flies during the period of June 30th to July 6th. No adults emerged in the laboratory after this date until the first of September and during this time adults were very scarce in the field.

Third brood.— A few first-brood pupæ transformed to adults early in September, and these made their appearance during the period of Aug. 31st to Sept. 9th. At these dates adults were still very scarce in the field and continued so until the 23rd of September. They were conspicuous in several fields from the above date until October 8th.

TABLE IV.— OBSERVATIONS ON *P. brassicæ* FOR THE YEARS 1909–10–11.

(Arranged in chronological order.)

Date.	1909.	1910.	1911.
May 8	....	....	Adults abundant.
May 12	....	Few adults in sunny places.	
May 13	Two adults...........	....	Adults numerous.
May 14	Adults on chickweed blossoms.		
May 16	Few flies close to ground	Flies scarce.	
May 19	Adults numerous......	Few adults on shrubs and mustard.	Adults numerous.
May 22	A few hiding in cracks in soil in pea field.		
May 24	Adults ovipositing.....	....	Adults abundant about radish roots.
May 27	....	Adults hiding in soil...	Not so numerous.
May 28	Adults ovipositing.		
June 2	Males numerous on weeds at 7 A. M. No females.	Flies numerous on vegetation.	
June 6	....	Eggs still being deposited.	Adults more numerous than for several days.

TABLE IV (*continued*).

Date.	1909.	1910.	1911.
June 8	Mustard in bloom. Flies about blossoms and roots.	No eggs deposited. Adults taken by sweeping mustard.	
June 10	Few adults collected...	....	Few adults in the field.
June 17	....	Adults not numerous...	Adults emerging in abundance in laboratory 10th to 17th.
June 20			
June 25			
June 29			
July 8	June 20th to July 8th. Adults emerging in considerable numbers.	June 20th to Aug. 2nd. Adults emerging in sparing numbers both in cages and out side.	
July 15			
July 20			
July 25			
July 30			
Aug. 1			
Aug. 3	....	Flies very abundant about tops of cabbage plants.	June 20th to Aug. 20th adults very hard to find in field. None emerging in laboratory.
Aug. 8	....	Females numerous about cabbage and peas.	
Aug. 11	....	Females observed at droplets of dew on cabbage.	
Aug. 15	....	Females heavy with eggs.	
Aug. 24	....	Adults collected by sweeping turnips.	Adults very scarce.
Aug. 25	Aug. 25th to Sept. 5th. Adults emerging in considerable numbers.		
Aug. 30		Adults numerous......	Aug. 30th to Sept. 10th very few adults emerging in laboratory.
Sept. 5			
Sept. 10	Sept. 5th to 22nd few adults emerging.	Adults numerous......	Males very scarce.
Sept. 16			Males very scarce.
Sept. 18			
Sept. 20	....	Few adults.	
Sept. 23	....	....	Adults observed.
Sept. 29	....	Few adults on cabbage and turnips.	Adults very scarce.
Sept. 30	....	Adults collected on mustard.	

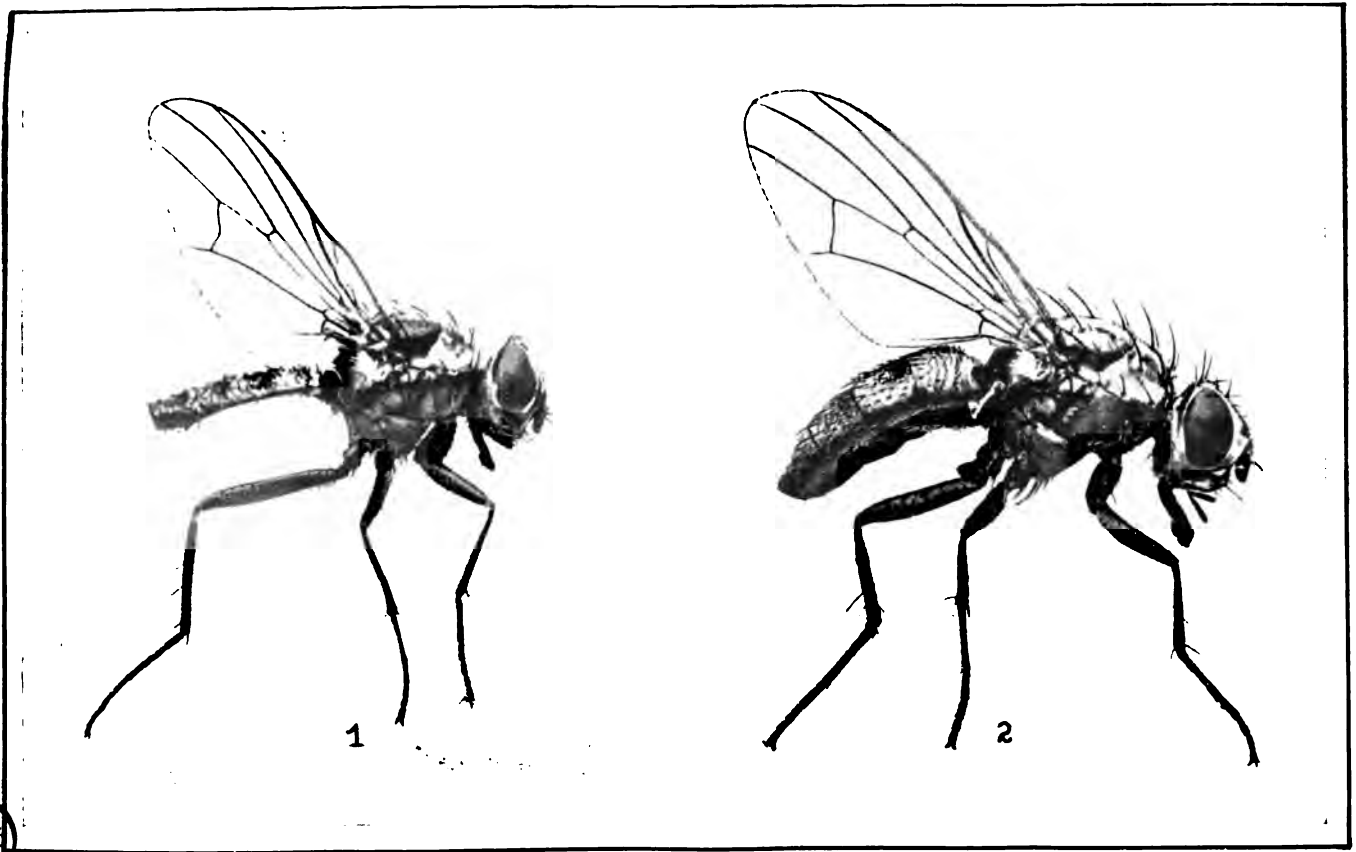

Plate XXXIX.— Adults of Cabbage Maggot: 1, Male; 2, Female

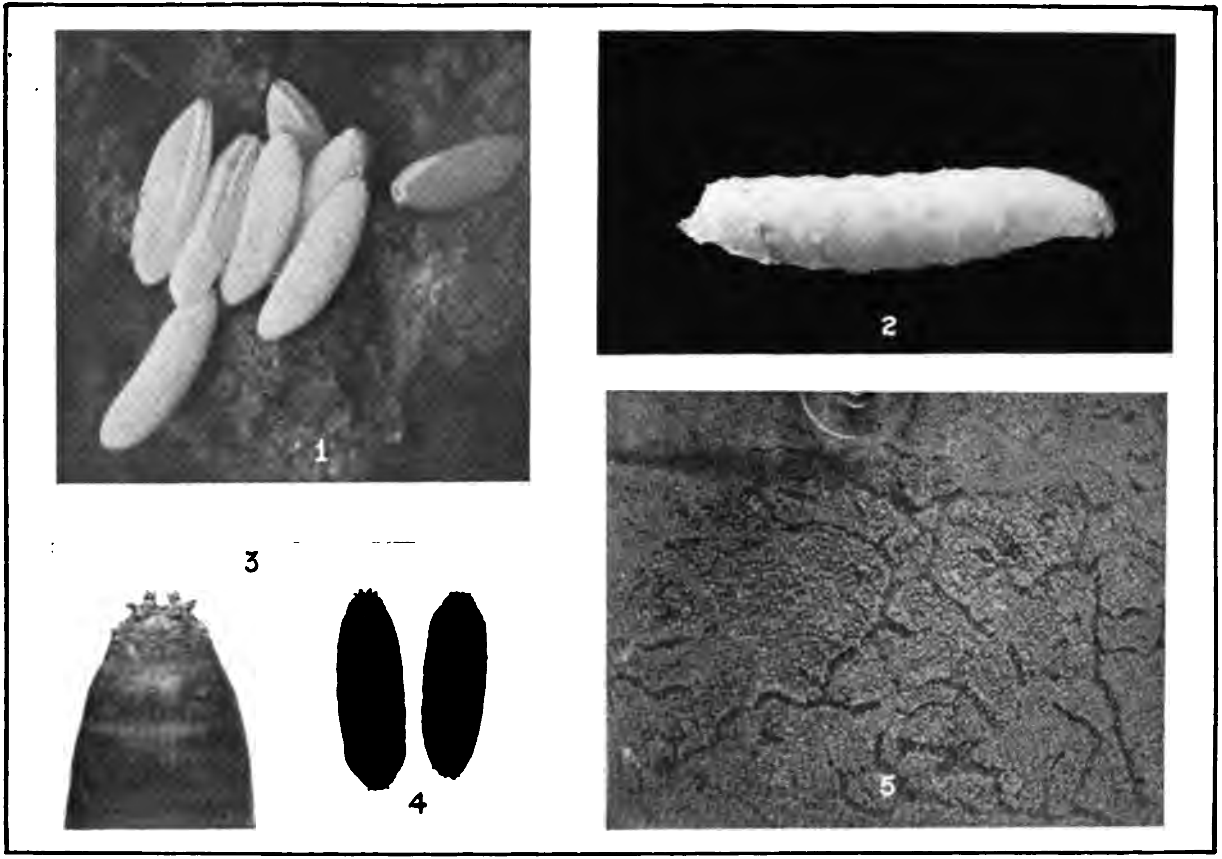

PLATE XL.— LIFE STAGES OF CABBAGE MAGGOT.

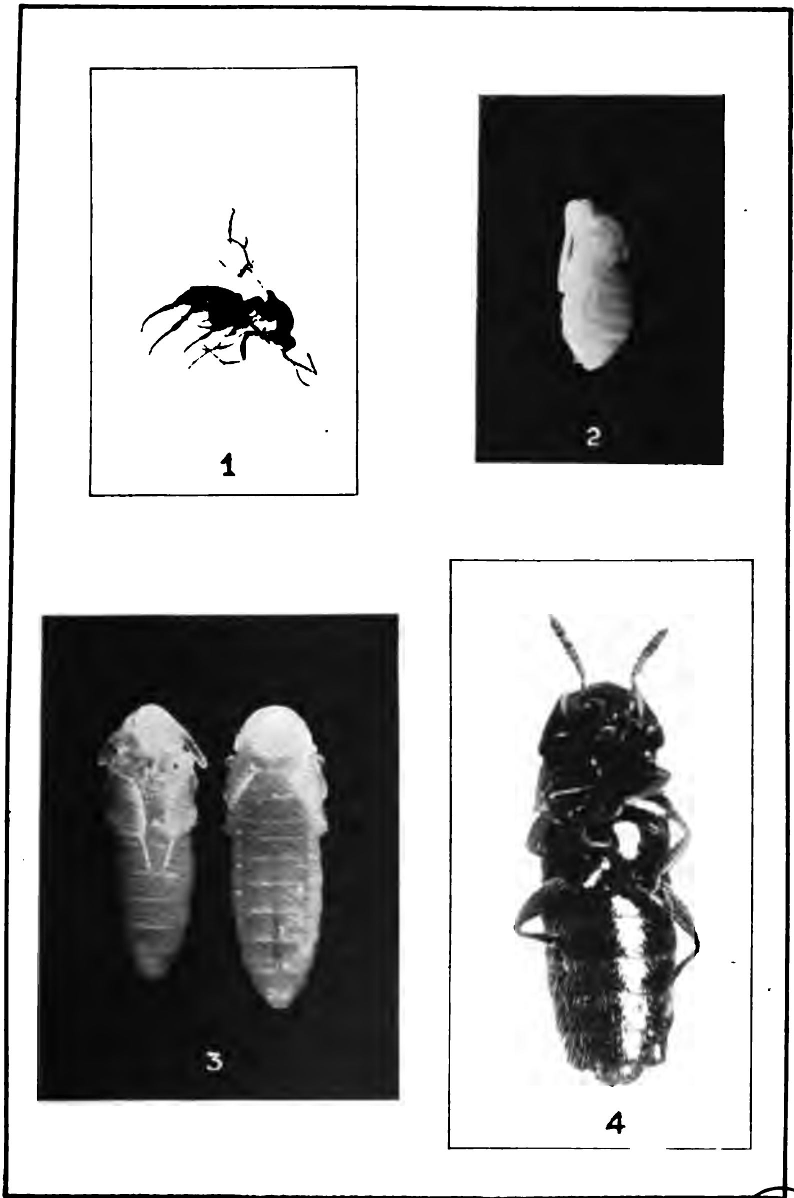

PLATE XLI.— PARASITIC AND PREDACEOUS ENEMIES OF CABBAGE MAGGOT.
Cynipid adult (1) and pupa (2); staphylinid pupæ (3) and adult (4).

PLATE XLII.— INJURIOUS WORK OF CABBAGE MAGGOT.
1, Different degrees of root injury; 2, damages to seed bed.

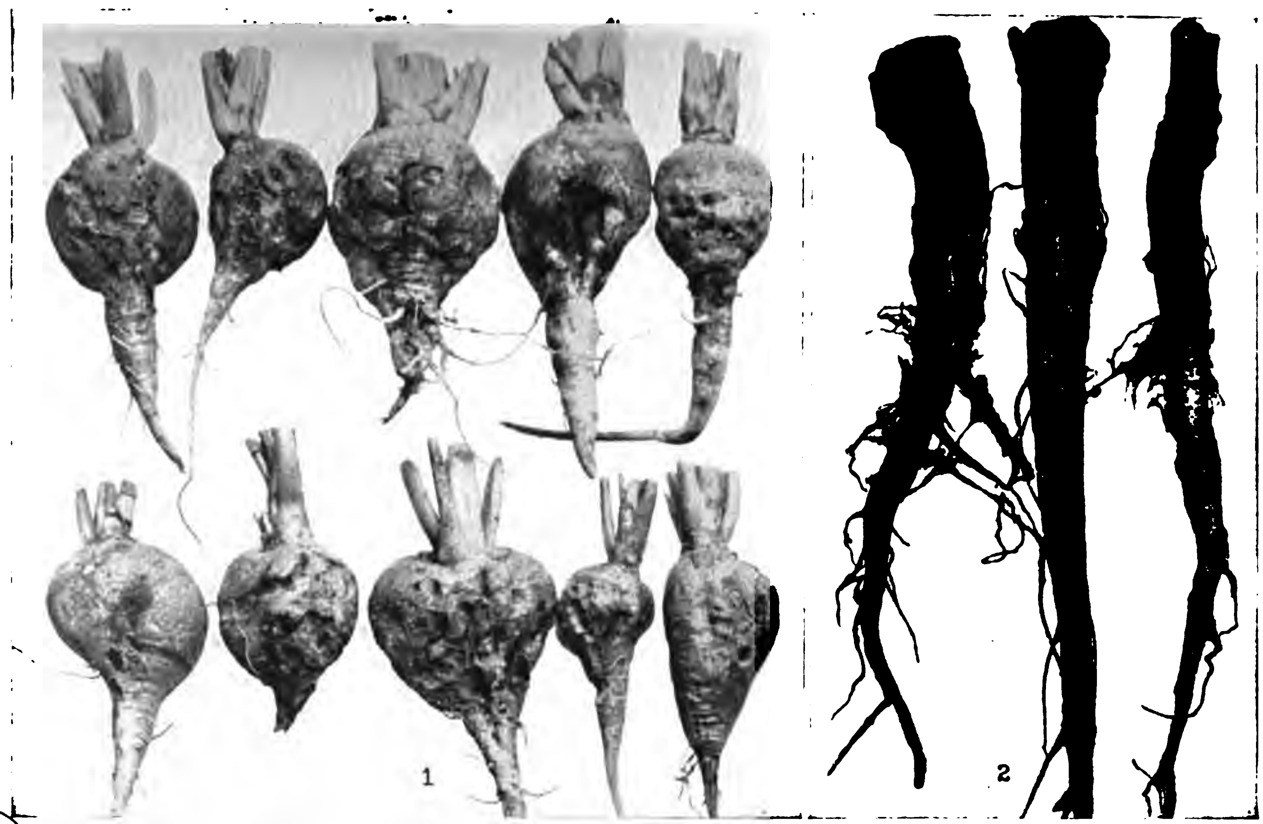

PLATE XLIII.— INJURIOUS WORK OF CABBAGE MAGGOT ON RADISHES (1) AND WHITE MUSTARD (2).

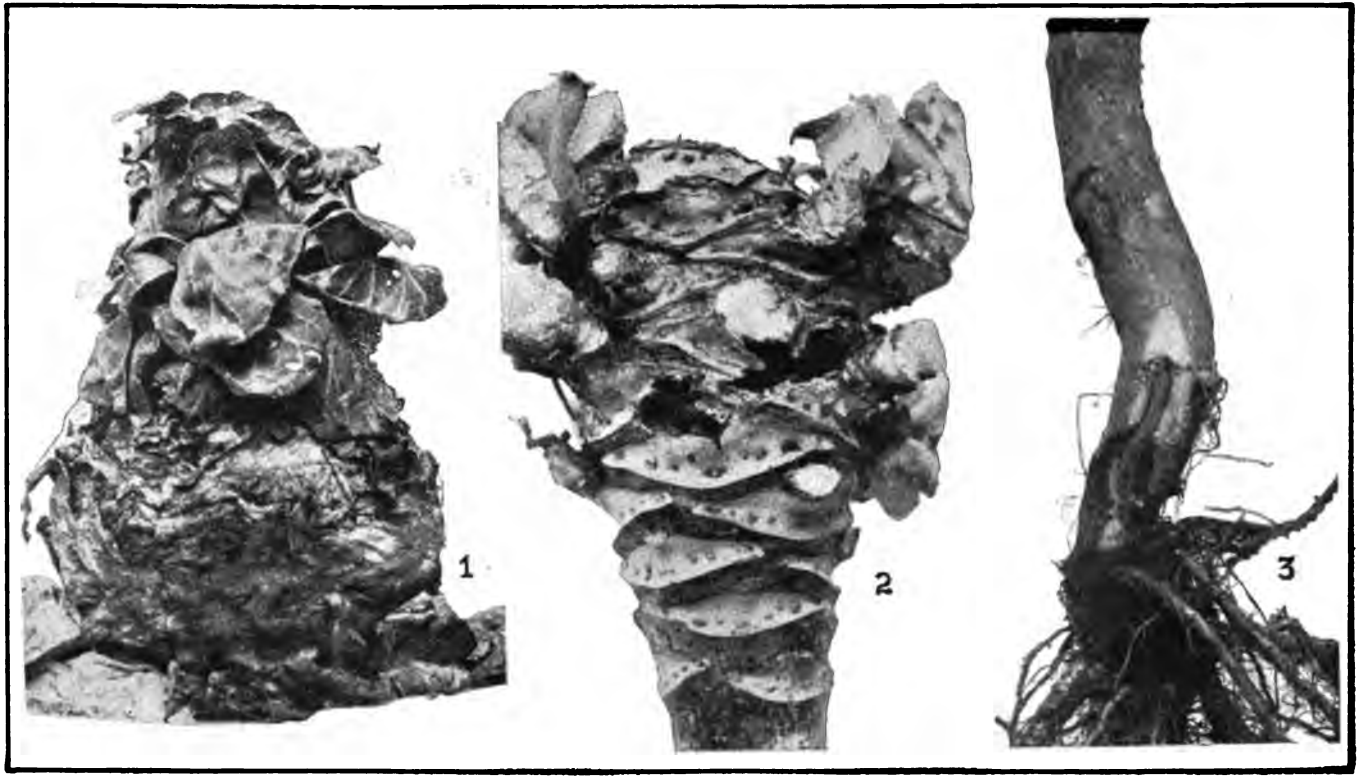

Plate XLIV.— Damages by Fall Brood of Cabbage Maggot on Sprouted Cabbage (1), Cabbage Stalk (2) and Cabbage Roots (3).

Plate XLV.— Cabbage Seed Bed Protected during Early Growth by Cheesecloth Screen

PLATE XLVI. – PROTECTING EARLY CABBAGE BY TAR-PAPER DISKS.

TABLE V.—AVERAGE MONTHLY TEMPERATURE READINGS AND PRECIPITATION DURING CABBAGE MAGGOT ACTIVITY.

(Precipitation in *Italic.*)

	May. Max. Min.	June. Max. Min.	July. Max. Min.	Aug. Max. Min.	Sept. Max. Min.
1909	69.8 40 *2.83*	79.2 55.3 *2.17*	81.6 57.6 *2.04*	83 56.9 *2.21*	76.2 50.8 *2.22*
1910	65.8 44 *3.45*	76.9 53.5 *1.56*	85 61.3 *2.39*	80.8 57.2 *5.47*	74.1 52.4 *3.29*
1911	79.3 50.5 *1.36*	79.1 55.9 *2.51*	88.2 60.7 *4.49*	82.2 59.6 *3.36*	73.8 51.8 *3.21*
Average precipitation for previous 20 years	*2.94*	*3.33*	*3.71*	*3.30*	*2.40*

SUMMARY OF DATA BEARING ON NUMBER OF BROODS.

The statements presented in the previous paragraphs are based on data resulting from the collection of adults as they emerged from infested cabbage seed beds supplemented by numerous field collections. These data show first that adults are always present in large numbers during the latter half of May. This has not only been true during the eight seasons covering these observations, but the fact has been noted by all persons who have studied this insect. However, the most important fact that has been brought out by the life history studies is that the number of adults present during July and August varies from year to year. In some seasons the adults are comparatively numerous during this period and during other seasons there are practically none. Some effort has been made to correlate the numbers of adults with certain conditions of summer weather. It appears that varying percentages of the adults of the second brood are delayed in emerging and that these delayed insects may remain in the pupa stage for six or eight weeks and emerge about September first.

In this connection, attention is called to Table V. The average of the daily maximum temperatures during May, 1910, was 65.8° F. with a precipitation of 3.45 inches. As compared with these records the weather of May, 1911, was as follows: Average of maximum

temperature 79.3° F., precipitation 1.36 inches. It will be observed that there is a difference of 13.5° F. in the averages for this month during these two years.

The experimental data presented in a later chapter suggest that these differences in temperature may, in part, account for the retardation in the time of appearance of some individuals.

In addition to any direct influence meteorological conditions may have on the development of the insect and the numbers that mature, there is always an indirect effect due to the influence of the weather upon the growth of the plants. It seems very logical to assume that the numbers of larvæ that reach maturity would depend somewhat upon the rate of growth and the succulence of the host. If a number of young larvæ infested a small plant that was making a slow growth, all individuals might fail to mature, whereas, if the seedling were growing rapidly it would support a number of larvæ without being seriously affected. During July and August both wild and cultivated cruciferous plants make a hard woody growth and this is unfavorable to the younger stages of the insect.

In conclusion, it is apparent from the foregoing data that there have been differences in the time of the appearances of the later broods, and that these have been coincident with abnormal precipitation and temperature. This situation has been interpreted in the same way as that outlined by Osborne[1] and Webster[2] for the Hessian fly, which is that high temperature or severe drouth causes a retardation of developing larvæ and pupæ.

The weather in this climate varies considerably from year to year. Some summers are characterized as wet, others as dry and hot. These differences have an important influence on the growth of cabbage, and it follows that the insects feeding upon this crop are to some extent affected. Abundant moisture makes an abundance of succulent growth which is very favorable to root-infesting insects; dry, hot weather produces a stunted woody growth upon which maggots feed very little or not at all. In addition to this indirect effect, all stages of the insect are influenced directly by weather conditions. The activity of the adult is probably shortened for want of moisture in dry, hot weather, and there occurs in the juvenile stages a retarda-

[1] U. S. D. A. Ent. Bul. 16, N. S., p. 24.
[2] U. S. D. A. Ent. Cir. 70, p. 11.

tion in development during which the insect remains dormant until the return of suitable conditions.

HIBERNATION.

Peter Friedrich Bouché, in his Naturgeschichte der Insekten, 1834,[1] says, "Spätlinge überwintern theils als Fleige, . . . theils als Puppe in der Erde." Curtis in *Gardeners' Chronicle*, 1841,[2] continues, after describing the summer broods, "later families lying in the pupa state through the winter, and most probably some of the flies survive that season secreted in holes and crevices." Taschenberg[3] in Naturgeschichte der wirbellosen Thiere, states that both the flies and pupæ hibernate. In 1884 Riley[4] reports: "The insect hibernates both in the larva state in the roots and in the puparian state underground." Fyles[5] examined radish roots in November that were known to be infested in October and found no maggots, which indicated that the insects did not pass the winter in the larval stage. Slingerland,[6] after a discussion of hibernation, adds: "It is not at all improbable that the flies do pass the winter secreted in crevices or under rubbish." Smith[7] states that he has found the adults so late in the fall and so early in the spring that there can be no question as to the fact that the winter is passed in this stage.

Our observations on this phase of the problem were made during the autumns of 1907 and 1910 and during the spring and fall of 1911. The data accumulated during the autumns of the three seasons is given in Table VI, while observations made in the spring of 1911 are given in chronological order in Table VII. Attention is called to the following facts that are brought out by these observations: (1) a scarcity of both adults and larvæ during the latter part of the summer; (2) a period when adults are numerous and females heavy with eggs are frequently collected; (3) a period when eggs and maggots are numerous; (4) a variable interval preceding cold weather when no adults can be found; (5) that during the spring of 1911 pupæ under normal conditions in the soil reached maturity and adults emerged from the ground on the same day that flies were observed in the field for the first time that season.

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[1] Bouché, Natur. der Insekten, p. 74. Berlin 1834.
[2] Gardeners' Chron., p. 396, 1841.
[3] Taschenberg, Natur. der wirb. Thiere, pp. 172–175. 1865.
[4] U. S. D. A. Rept. p. 320. 1884.
[5] Rept. Ent. Soc. Ont. 21:44–45. 1891.
[6] Cornell Exp. Sta. Bul. 78:516.
[7] N. J. Exp. Stas. Rept. 488:1895.

In some seasons it has been almost impossible to find adults during the latter part of the summer in locations where they were present in considerable numbers both in early summer and again in the fall. During cool days of September and October flies were found hiding in wild mustard and about uncut heads and sprouted stalks of cabbage. It is thought that if the adults hibernated some of them would remain in these hiding places, but in the inspection of many fields in the autumns of 1910 and 1911, during which crop remnants were thoroughly examined, no living adults were found. On Nov. 28, 1911, twenty-three pupæ and four larvæ were taken from the soil about cabbage roots. Some of the pupæ were the color of larvæ and had apparently just transformed, while others were fully formed. It frequently happens that snow drifts cover a portion of a cabbage field for the entire winter which preserve the plants in perfect condition until the following spring. It is very probable that any late emerging adults caught in such a situation would hibernate. The winter of 1909–10 was just such a season, for the country generally was protected by snow and whole fields of cabbage stumps put forth new growth in the spring, whereas, usually the plants are killed by low temperature. These observations indicate that about Geneva, N. Y., practically all of the insects winter as puparia and that the adults do not hibernate.

TABLE VI.— FIELD OBSERVATIONS ON PRE-HIBERNATION HABITS OF CABBAGE MAGGOT.

(Data for autumns of 1907, 1910, 1911, at Geneva, N. Y., arranged chronologically.)

Date.	1907.	1910	1911
Sept. 8	....	Adults numerous about tops of plants. No larvæ and no recent injury.	
Sept. 16	6 adults collected......	....	Males very scarce, none found.
Sept. 18	....	....	Males very scarce, 2 captured.
Sept. 20	....	Adults observed. Only an occasional larva found on cabbage and turnips.	
Sept. 22	8 flies taken.		
Sept. 28	....	Female taken. Adults seen on cabbage and turnips.	Adults very scarce.
Sept. 30	....	Adults of both sexes collected on mustard.	

TABLE VI (*continued*).

Date.	1907	1910	1911
Oct. 2	....	....	Adults very scarce, 1 male taken, on sunny side of cabbage. T. $54\frac{1}{3}°$ 4 P. M.
Oct. 3	Flies plentiful and ovipositing. Half-grown larvæ abundant.	Flies abundant, active and abdomens heavy with eggs.	
Oct. 8	....	....	Adults more numerous than any time this fall.
Oct. 9	A few adults present. Most larvæ ready to pupate. Some pupæ.		
Oct. 10	....	No flies seen.	
Oct. 12	....	Adults scarce, 1 male captured.	
Oct. 14	....	Some flies taken on mustard.	
Oct. 16	Larvæ and adults abundant.		
Oct. 17	....	Adults not found.	
Oct. 18	....	Careful search. Adults not found.	
Oct. 20	....	Larvæ numerous in stumps.	
Oct. 22	Difficult to find adults. Various sized larvæ present.		
Oct. 24	....	Larvæ numerous in stumps.	Eggs and all stages of larvæ numerous. No adults seen.
Nov. 6	....	Larvæ numerous in stumps.	
Nov. 9	....	....	Many larvæ present, but most of them of large size. No flies.
Nov. 12	Larvæ abundant about roots of turnips and cabbage. No adults present.		
Nov. 24	....	....	Larvæ in stalks and heads killed by frost.
Nov. 28	....	....	23 pupæ and 4 maggots taken from about roots of cabbage.
Dec. 10	Larvæ present in roots of turnips.		

TABLE VII.— DEVELOPMENT OF HIBERNATING PUPÆ OF CABBAGE MAGGOT.
(Chronological arrangement of notes taken in Spring, 1911.)

1911.		
March	13.	Examined cabbage stumps, ground frozen, some dead larvæ noticed.
April	6.	Examined 10 stumps. 14 puparia collected. The white legs could be seen through the pupal skin.
April	12.	4 pupæ dissected, legs just formed.
April	21.	Collected 30 puparia from about 15 stumps. Development same as in previous examination.
April	27.	14 puparia taken about 8 stumps.
April	28.	By sifting soil obtained 24 puparia from 14 stumps. 9 of these were dissected, and all showed completely formed pupæ.
May	4.	6 puparia from about 14 stumps. These were examined with the following results: 2. Pupæ shaped but no pigment. 1. Slight pigment in eyes. 2. Legs, etc., slightly pigmented. 1. Legs, wings, antennæ pigmented. Eyes almost natural color.
May	6.	Another collection examined as follows: 12. Pupæ formed, no pigment. 1. Eyes slightly pink and a row of pigmented chætæ around head. 1. Eyes reddish pink, antennæ, wings and legs pigmented.
May	8.	Sifted soil about 46 stumps, taking 52 pupæ, and several fresh looking specimens. A number of the pupæ appeared to be mature and ready to transform and one did transform to an adult before the following day. First adults noticed this season.
November	28.	By sifting, 23 puparia and 4 maggots were taken about roots of cabbage.

EXPERIMENTAL STUDIES ON THE EGG AND PUPAL STAGES.

INCUBATION PERIOD AND INFLUENCE OF MOISTURE AND TEMPERATURE CONDITIONS.

DURATION OF EGG STAGE

Taschenberg[1] states that the eggs hatch in about ten days. Mr. P. H. Scudder of Glen Head, Long Island, reported to Slingerland that the eggs hatched in from four to ten days, depending upon weather conditions.[2] Smith[3] states the egg stage varies from four to ten days and probably averages about a week. Washburn[4] observed the duration of the egg stage on two individual eggs, and the period from oviposition until the eggs hatched was respectively three and five days. The following experiments were made to secure additional data on the duration of the egg stage and the effects of moisture and temperature on the length of the incubation period.

[1] Natur. der wirb. Thiere, p. 172–175. 1865.
[2] Cornell Exp. Sta. Bul., 78, p. 507.
[3] N. J. Exp. Sta. Bul., 200, p. 7. 1907.
[4] Minn. Exp. Sta. Bul., 100, p. 5. 1906.

EXPERIMENTS TO DETERMINE EFFECTS OF MOISTURE AND TEMPERATURE ON INCUBATION PERIOD.

The eggs used in these tests were secured from about the roots of cabbage plants in the field. The time of oviposition was ascertained within specified limits by previously removing the infested earth from about the stalk and adding fresh earth. Unless the moisture conditions are given, the eggs in each experiment were placed in an unglazed clay saucer. A uniform condition of moisture was maintained by plunging this receptacle in damp sand. The first six of the following tests were made in the laboratory which has an approximate average temperature of 68° F., and the number of eggs used in these six tests varied from twelve to two hundred in each series. Each of the other lots contained twenty-five eggs, and the temperature conditions are included in the description. An average of twenty-four hours lapsed before the conditions of the experiment were imposed.

Details of egg-hatching tests: *Test No. 1.* Eggs deposited on May 26, 1908, hatched by June 1st. Time, less than five days.

Test No. 2. Some eggs deposited between 8 A. M. and 4 P. M., June 3, 1908, began to hatch by five P. M., June 6th. Time, about three and one-fourth days.

Test No. 3. Eggs deposited between 8 A. M. and 4 P. M., June 4, 1908, were partly hatched by four P. M., June 7th. Time, three and one-fourth days or less.

Test No. 4. Eggs deposited between 8 A. M. and 4 P. M., June 5, 1908, were beginning to hatch 9 A. M., June 8th. Approximate time, three days.

Test No. 5. Eggs deposited between June 1st, 9 A. M. and June 2nd, 11 A. M., were hatching on the morning of June 5th. Approximate time, three and three-fourths days.

Test No. 6. Eggs deposited on June 8th were all hatched June 12th. Approximate time, four days.

Test No. 7. Eggs, twenty-five specimens, deposited May 27, 1909, were placed in a storage room with a temperature of 66 to 69 degrees F. May 30th, 6. P. M. one egg hatched. May 31st, 8 A. M., 12 eggs hatched. Average time, four days.

Test No. 8. Eggs deposited May 27, 1909, subject to an incubator temperature of 79 degrees F. May 30th, 6 P. M., 20 eggs hatched. Average time, three and one-fourth days.

Test No. 9. Eggs deposited May 27, 1909, and placed in an incubator at a temperature of 104 to 106 degrees F. No eggs hatched.

Test No. 10. Eggs deposited on June 3, 1909, were subjected to a temperature of 66 to 69 degrees F. June 6th, 10 A. M., five had hatched. June 6th, 7 P. M., 24 had hatched. Average about four days.

Test No. 11. Eggs deposited June 3, 1909, were placed in an incubator at a temperature of 79 degrees F.

June 6th, 10 A. M., 13 eggs hatched.
June 6th, 7 P. M., 20 eggs hatched.
June 7th, 9 A. M., 23 eggs hatched.

Average time, three and one-eighth days.

Test No. 12. Duplicate of number (3). Eggs deposited June 3rd were subjected to an incubator temperature of 104 to 106 degrees F. No eggs hatched.

Test No. 13. Eggs which were deposited June 3, 1909, were put in a dry unglazed saucer and exposed in a south window, unprotected from light and air. During the period the weather was cloudy. No eggs hatched.

Test No. 14. Eggs deposited June 3, 1909, were placed in a similar container to those of lot four. These were put in cold storage at a temperature of 60 to 64 degrees F. No eggs hatched.

TABLE VIII.— SUMMARY OF HATCHING TESTS OF EGGS OF CABBAGE MAGGOT.

NUMBER OF TEST.	Approximate temperature.	Moisture conditions.	Average time to hatch.
	Degs. F.		*Days.*
1	68	Moist sand	5
2	68	Moist sand	3¼
3	68	Moist sand	3¼
4	68	Moist sand	3
5	68	Moist sand	3¾
6	68	Moist sand	4
7	66	Moist sand	4
8	79	Moist sand	3¼
9	105	Moist sand	None hatched.
10	66	Moist sand	4
11	79	Moist sand	3⅛
12	105	Moist sand	None hatched.
13	68	Dry sand	None hatched.
14	62½	Moist sand	None hatched.

As shown by these tests the time required for the eggs to hatch in the laboratory where the temperature approximated 68° F. was about three and one-half days. Eggs held at a temperature of 79° F. in each case hatched a few hours sooner. Those subjected to a temperature of 105° did not hatch. It is significant that eggs exposed to light and air failed to incubate.

It should be noticed that all the eggs used in the above experiments were under the same temperature conditions during an average period of twenty-two hours after they had been deposited. The differences in the behavior of the eggs were apparently due to changes in temperature influences during the last two or two and a half days of the incubation period.

These tests strongly suggest that under field conditions during May and June the incubation period would vary from three to five days. Unusual temperatures would undoubtedly cause greater variations in the time of hatching.

PUPAL STAGE AND INFLUENCE OF ENVIRONMENTAL FACTORS ON DEVELOPMENT.

TIME REQUIRED FOR THE PUPA STAGE.

It appears that weather conditions influence the resting stage and that this period may be lengthened or shortened to such an extent that the insect is one-, two- or three-brooded. As stated previously [1] it was believed that the widely divergent periods given by different authors as to the time required for the pupal stage of *P. brassicæ* are due to unnatural surroundings. It was further thought that placing pupæ out of doors in the soil would result in a normal period that would be approximately similar for all individuals. However, as already described, the results of this kind of breeding work during 1909 and 1910 showed a wide variation in the time of the pupal period. As the conditions of the experiment were very similar to those obtaining in the soil and the results were confirmed by field collections, it is thought that these differences occur in nature.

Further observations show that the pupal period may be influenced by such factors as temperature and moisture. The following experiments were made to ascertain the importance of these factors under field conditions.

[1] *Jour. Econ. Ent.* 4:210. 1911.

EFFECT OF DIFFERENT AMOUNTS OF MOISTURE ON PUPAL DEVELOPMENT.

Experiment 1, with varying conditions of moisture. — The pupæ were divided into two lots, one of which was placed in flower pots out of doors (discussed as 1A), and the other in glass fruit jars which were placed in the laboratory (referred to as 1B). The pupæ used in this experiment were secured at the same time from radishes, and the conditions of experiment were imposed on June 1st.

Experiment 1A was designed to learn the effect of different conditions of moisture, keeping the other factors as nearly the same as possible and have the experiment outside, being protected only from rain. Twenty-five pupæ were placed in each of the five specially prepared, 10-inch flower pots on June 1st. The earth and pots were weighed from time to time and water added to bring the moisture content up to the calculated amount. The soil was a heavy clay, very similar to the soil in many fields used for growing cabbage in this locality. The moisture contents and the emergence of adults are given in Table IX.

TABLE IX.— DATES OF EMERGENCE OF ADULTS OF CABBAGE MAGGOT UNDER DIFFERENT CONDITIONS OF MOISTURE.
(Experiment 1A.)

NUMBER OF BREEDING POT.	Variations in moisture.	ADULTS EMERGED.				
		June 10.	June 13.	June 16.	June 21.	June 26.
	Per ct.					
A-1	4½ to 5½	......	7	3	......	......
A-2	6 to 7	5	......	12	......	......
A-3	8 to 10	2	......	7	......	......
A-4	11 to 15	......	......	6	1	1
A-5	20 to 23	......	......	9	3	......

Experiment 1B was designed to test the effect of moisture variations and was made in fruit jars with tops tightly plugged with cotton. Both soil and jars were weighed. Four hundred gms. of earth and 15 puparia were placed in each jar except number 6 which contained 25 puparia. It was estimated that the soil contained 2 per ct. of moisture and this was deducted in making up the amount in each

case. The water content of these jars and dates of emergence of adults are tabulated in Table X.

Table X.— Emergence of Adults of Cabbage Maggot Under Different Conditions of Moisture.

(Experiment 1B.)

Number of Jar.	Variations in moisture.	Dates of Emergence.			
		June 10.	June 11.	June 13.	June 16.
	Per ct.				
1	2	....	....	....	2
2	4	5	5	1	....
3	6	6	5	1	....
4	8	3	3	3	....
5	10	5	4	2	....
6	12	4	11	4	....
7	14	3	5	3	....
8	16	1	4	4	....
9	20	1	5	3	....
10	24	....	1	4	1

Results.— Two things are evident in the results of this experiment: 1, That at these temperatures, variations in soil moisture alone, within the limits of natural soil conditions, apparently have no effect on the pupa that has begun its development; 2, the conditions of temperature must have been very near the optimum. It is also of interest to note that in 1B, Jar 1 to which no water was added, only two adults emerged, the development of the other pupæ being arrested. As the earth used in this experiment had been previously baked for five hours at a temperature of 225°, it contained very little moisture and undoubtedly acted as a desiccator.

Experiment 2, with varying amounts of moisture.— The puparia were about five days old when the experiment was initiated on June 24th. Most of them looked very dry and some showed vacuoles of large size. Water was placed in the jars according to the following table and 10 puparia and 200 gms. of sand added. These jars remained in the laboratory from June 24th to August 16th. The outside temperature during this period ranged as high as 105° F., on July 5th, while the average maximum temperature for this time

was 88°. From August 16th to Sept. 8th, the insects were kept in a damp cellar. The data are presented in Table XI.

TABLE XI.— EXPERIMENT SHOWING THE EFFECT OF VARYING AMOUNTS OF MOISTURE ON PUPÆ OF CABBAGE MAGGOT.

(At room temperature from June 24 to August 16.)

Number of Jar.	Variation in moisture.	Adults Emerged.					
		June 24.	July 1.	July 3.	July 5.	Aug. 16.	Sept. 8.
	Per ct.						
1	2	Experiment initiated. Jars placed in laboratory.	1	2	......	......	....
2	4		1	1	1	......	....
3	7		......	1	......	Jars moved to cellar.	....
4	9		......	1	......		....
5	12		......	1	......		....
6	14		1	1	......		....
7	17		......	......	......		1
8	19		......	1	2		....
9	22		......	......	......		....
10	26		......	1	1		....

Conclusion.— From the foregoing data it appears that increasing or decreasing the moisture within the limits of field conditions did not affect the insects after development had started, for those individuals that were nearly ready to emerge when the conditions were imposed were able to mature. The development of the majority of the puparia was probably arrested by the hot weather prior to the experiment, and during the period of high temperatures when the experiment was made these insects were apparently not affected by increasing or decreasing the amount of moisture in the soil. The death of many of the insects appears to have been due to continued high temperatures.

Experiment 3, to determine the effect on pupal development of varying amounts of moisture coupled with high temperatures.—The puparia used in this experiment were one to two days old. They were taken June 20th from about radishes that had been collected seven days previously. Fifteen puparia and 400 gms. of air-dry quartz sand were placed in glass fruit jars with the amount of water as follows:

There were ten jars, one with oven-dried sand and no moisture added, three with air-dried sand, no moisture, and six jars, two

having six per ct., two ten per ct. and two twenty-two per ct. moisture. These jars were placed in an incubator at a temperature of 93° F. but the temperature actually ranged from 90° to 105° F. The jars remained in the incubator from June 20th to July 11th and in the laboratory until Oct. 24th. The test was started on June 20th. Two adults emerged on June 27th and two on Aug. 8th from one of the jars containing air dry sand. No others emerged.

Conclusion.— The temperatures are too high for the development of the pupæ, and the addition of moisture makes conditions suitable for fungus. The fact that four adults emerged indicates the ability of some pupæ to withstand very unfavorable conditions.

Summary of the moisture experiments.—After the puparium is formed the rate of pupal development is not hastened or retarded by such changes in soil moisture as would ordinarily occur in this region. Severe desiccation arrests development while high temperatures are unfavorable to development.

EFFECT OF DIFFERENT TEMPERATURES ON THE DEVELOPING PUPÆ.

Experiment 4, to determine the delay in pupal development by deep burial.— The puparia used in this experiment were collected on April 20th from about cabbage stumps. At this time tile-drained fields were being plowed. The experiment was started the following day, or April 21st. The puparia were divided into four lots: one lot was buried nine inches in the soil while the remainder were used as controls, two of which were placed in an incubator at a temperature of 78°–80° F. and one in an ice house.

TABLE XII.— EMERGENCE OF ADULTS OF CABBAGE MAGGOT MODIFIED BY DIFFERENT TEMPERATURES.

CONDITIONS.	No of puparia.	April.	MAY.							JUNE.				
		21	3	8	13	15	17	22	27	5	5	10	13	16
Incubator A.....	4	Experiment started.	...	Flies appeared outside.	1	...	1	...	...	Removed to laboratory.	...	...	...	...
Incubator C.....	6		1		...	...	1	...	...		...	...	...	...
Ice house.......	5		...		...	...	...	...	...		1	2	...	1
9 inches soil....	5		...		...	...	...	1	1		...	1	1	1

Results.— A glance at Table XII will show that the time of emergence was materially affected by the different conditions of the experiment. As stated, the test was initiated April 21st, and the first adult to emerge from the lot buried in the soil appeared May 22nd, while the first adults appeared outside on May 8th. In other words pupæ buried to a depth of nine inches emerged fourteen days later than the earliest appearing adults under normal conditions in the field. One lot required eighteen days and the other thirty-two days to go through the same transformations. These data are confirmed to a certain extent by another test [1] in which infested soil was plowed six or nine inches. In this case there was a difference of ten days in the appearance of adults in the two situations.

Experiment 5.— This was planned to determine the effects of four different conditions of temperature upon the development of pupæ. Eight jars were prepared with one pint of soil in each, the even numbers containing fine sand just moist enough to cake when squeezed, while the odd numbers contain the same material air dry. The puparia were taken from about radishes three days previously. It is probable that they varied from four to five days in age. Ten puparia were placed in each jar.

Two important facts are shown in Table XIII. Some pupæ in a cool, moist cellar appear to have been enabled to finish their development and emerge, while of other pupæ retained at a temperature of 98° F., and of another lot at a temperature of 80° to 89° F., and an occasional maximum of 95°, none emerged. The insects placed in the basement, which was dark though not damp nor as cool as the wine cellar, did not respond to the change as quickly. Perhaps second in importance is the fact that the conditions of contained earth, whether dry or moist, seem to have had no effect on the emergence of adults.

The actual number of individuals involved in this experiment is small, and standing alone it would be lightly considered; however, this behavior is parallel to that outlined by W. Paspelow [2] for the Hessian fly. The results also almost duplicate those of a similar experiment performed in 1909, but not as yet recorded. In addition there were two other lots of pupæ which were placed in the wine cellar with series 7, Experiment 5, eight of which behaved in the

[1] See data on emergence of spring brood, page 358.
[2] U. S. D. A. Ent. Bul., n. s. 16, p. 22.

same manner. In contrast to this there were several lots of pupæ left in the laboratory subject to the continued warm, dry weather, which yielded no adults.

TABLE XIII.— EFFECTS OF DIFFERENT CONDITIONS OF TEMPERATURE UPON SUMMER PUPÆ AND EMERGENCE OF ADULTS OF CABBAGE MAGGOT.

No. of jar.	Condition of sand.	Conditions of temperature.	Adults Emerged.					
			July 27.	Aug. 8.	Aug. 10.	Sept. 14.	Oct. 26.	Oct. 27.
1	Dry....	Degs. F. 80–86 occasionally 95.......	Experiment started.	.....	......	......	......	....
2	Moist..	Same....		.....	......	......	......	4 pupæ not collapsed.
3	Dry....	98.......		.....	......	......	......	....
4	Moist..	Same....		.....	......	......	......	All shriveled.
5	Dry....	Basement.		.....	......	1	1	....
6	Moist..	Basement.		.....	......	......	......	....
7	Dry....	Wine cellar..		1	2	......	......	....
8	Moist..	Wine cellar..		1	2	......	......	....

OBSERVATIONS INDICATING THAT A NORMAL PERIOD RESULTS WHEN OPTIMUM CONDITIONS FOR DEVELOPMENT OBTAIN.

In most of the previous experiments the conditions have been severe and as a result many pupæ have died and only a few have developed. However, in one experiment, and several times during our observations, there have been indications of a uniform period. In experiment 1B, jars 2 to 9 inclusive, 70 per ct. of the adults emerged during a period of four days, within twelve days after the conditions were imposed, and no more adults and only one parasite

emerged during the subsequent thirty-seven days. The average of the daily maximum temperatures for the period of June 1st to 13th was 78° F., and for the minimum 56°. The average of the same readings for the period these pupæ were held in the laboratory, June 24th to 31st, was 83° and 56° respectively. During July, 1909, collections were made of adults as they emerged from the soil under a cheesecloth screen. In the unplowed portion of the experimental plat [1] about 75 per ct. of the adults were taken during a period of seven days, while the collections covered a period of thirty-two days. The average of the maximum and minimum temperatures for twelve days prior to the first collection was respectively 83° and 55° F.[2] These temperatures were taken at the Station while the collections were made about six miles distant. These two instances show a tendency for a normal developmental period, and it is interesting to note that the temperatures in each case ranged near 80° F. for the maximum to 55° for the minimum.

DO PUPÆ UNDER SIMILAR CONDITIONS DEVELOP AT DIFFERENT RATES?

That pupæ under the same conditions behave differently has been obvious all through our studies of the species. This is the most important premise in this investigation. Pupæ in the same breeding cage and certainly subject to very similar moisture and temperature conditions do not develop in the same length of time. This delay of development is remarkably similar to the behavior of many seeds. It is a matter of common observation that some weed seeds continue to germinate for long periods. An experiment was performed by Nobbe and Hanlein [3] in which the seeds of a number of weeds were placed under conditions favorable to germination, and some of these continued to germinate throughout the experiment which lasted 1173 days. Certain facts indicate a difference in the rate of loss of moisture in the puparia of *P. brassicæ*. Referring to experiment 1B, jar 1, in which fifteen puparia were placed in a tight jar with very dry soil, two individuals showed a normal development. Seven of these puparia were examined on July 21st, at which time several of them appeared to be alive. In this experiment, the conditions were severe. Unquestionably desiccation

[1] *Jour. Econ. Ent.*, 4:215. 1911.
[2] N. Y. Exp. Sta. 28th Ann. Rept., p. 559. 1909.
[3] Bot. Gas. 42: 266.

prohibited development in thirteen individuals and failed to affect the remainder. Similar results were secured in Experiment 6, in which ten puparia were placed in a porcelain watch glass. The experiment was initiated June 27th and by July 6th one adult had emerged, one died in the act of emerging, while the other puparia appeared to be very dry. The puparia in this experiment were certainly subject to the same conditions. Such results have occurred many times, and the presence of a large vacuole in some of the retarded pupæ shows marked desiccation. These facts indicate that under some conditions pupæ lose moisture at different rates. A number of observations were made upon the relative loss of weight of pupæ in a desiccator and in water vapor and under other conditions of dryness. It was determined that weight is lost rapidly when pupæ are subjected to dry air, as in a warm room or a desiccator.

RATE OF LOSS OF MOISTURE FROM INDIVIDUAL PUPÆ.

Experiment 7.— For this work eight pupæ were selected from a lot that had pupated during the previous night. These were similar in general appearance and size. They were weighed and placed in a calcium chloride desiccator for two days, during which time two additional weighings were made as shown in Table XIV.

TABLE XIV.— LOSS AND GAIN OF WEIGHT OF PUPÆ OF CABBAGE MAGGOT.
(In desiccator for two days and subsequently placed in aqueous vapor.)

No. of pupæ.	Original weight 3 P. M. July 7th.	In desiccator: Weight 8 A. M. July 8th.	Weight 10:30 A. M. July 9th.	In water vapor: Weight 2 P. M. July 12.	Loss July 7 to July 8.	Loss July 8 to July 9.	Loss July 7 to July 9.	Gain July 9 to July 12.
	Gram.	*Gram.*	*Gram.*	*Gram.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
1......	.0105	.0058	.0038	.0049	44	34	63.8	22
2......	.0104	.0072	.0040	.0053	31	44	61.3	24
3......	.0104	.0075	.0033	.0046	28	56	68.2	28
4......	.0152	.0089	.0057	.0068	41	36	62.5	16
5......	.0145	.0099	.0058	.0073	31	41	60.0	21
6......	.0117	.0077	.0043	.0055	34	44	63.2	22
7......	.0130	.0075	.0046	.0058	42	33	64.6	21
8......	.0129	.0074	.0046	.0064	42	38	64.3	28

The insects were then placed in a sealed jar containing water vapor for three days and again weighed. These figures indicate that there was an appreciable variation in the rate of daily loss, but practically no difference in the loss during two days. There was also considerable difference in the rate of gain in weight in water vapor. These figures are open to criticism on account of the difficulty of weighing such small amounts.

As these weighings show slight variations in the rate of loss and gain, they corroborate the observations mentioned above. A slight disparity in loss of water might account in part for the differences in behavior by the insects.

LENGTH OF THE PUPA STAGE.

The peculiar differences that exist in the length of the pupal period seem to be due to a delayed or arrested development in which some individuals are affected more than others. This delay has been spoken of in entomological literature as retardation, and undoubtedly it is a form of æstivation. According to Tower[1] hibernation and æstivation are fundamentally alike, both terms applying to the same physiological process, the only difference being the factors which initiate them. He found that in addition to protoplasmic changes *L. decemlineata* lost 30 per ct. of its weight preparatory to hibernation, and that *undecemlineata* in preparation for æstivation in semitropical regions goes through the same process.

Thus it appears that the loss of water which enables the insect to withstand extremes of temperature is a prerequisite for either condition. Some observations have been made upon the rate of metabolism as affected by loss of water in seeds. Kolkwitz[2] experimented with barley and found that respiration decreases rapidly as the seeds lose moisture and that a rise in temperature increases respiration.

The ability of many plants and animals to withstand desiccation in some stage of their existence is common knowledge. Practically all seeds and many lower forms of animal life are able to survive certain unfavorable periods. One who has bred insects could hardly fail to observe cases of retardation and numerous instances are cited in literature. Lawrence Bruner[3] in discussing the great abundance

[1] Tower, W. L. Investigation of Evolution in Chrysomelid Beetles, pp. 245–252, 1906.

[2] Jost. Plant Physiology Ox. Ed. 1907, p. 341.

[3] U. S. D. A. Ent. Bul., N. S., 38, p. 44, 1904.

of grasshoppers in some years, states that when rain falls early the eggs hatch much sooner than when the rains come later in the season. After a late spring they continue to hatch after each shower. During some seasons it may be possible that many remain over until the next year, not hatching because of lack of sufficient moisture. He believes that these retarded eggs help to swell the numbers of insects if the season is favorable for hatching. This certainly seems possible in view of the experience of C. P. Lounsbury [1] who reports that locust eggs were known to retain their vitality for three and one-half years. Tower was of the opinion that certain species of *Leptinotarsa* [2] in the more arid portions of the American continent were able to survive the prolonged periods of unfavorable weather which occur in these regions. To prove this he placed beetles in a dry, warm container where they remained in a condition of hibernation for about eighteen months or from the fall of 1902 until May of 1904. Twelve to sixteen days is probably the normal time for development of the pupa of *P. brassicæ*, though periods of two and three months are reported by Slingerland. In our work a delay of two months in the maturing of pupæ has frequently been observed and in one instance a fly emerged from a pupa that was from nine to ten months old.[3]

Some plants and animals exhibit a seasonal or periodic behavior in their daily and annual functions, and the preparation for hibernation of many insects may be explained on this basis. This periodicity, which is due to an internal response, is strongly manifested in some organisms and practically absent in others. Some insects continue breeding without cessation when removed to the greenhouse,

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[1] 4th Ann. Rept. South African Central Locust Bureau, p. 7.

[2] Tower, W. L. Investigation of Evolution in Chrysomelid Beetles, pp. 245–252, 1906.

[3] A retardation such as occurs with the pupa of *P. brassicæ* has long been known to occur in the resting stage of the Hessian fly. Most interesting in this connection is the summary by Osborn (U. S. D. A. Bu. Ent. Bul. 16, n. s., p. 22) of a paper by Dr. W. Paspelow of the Agricultural Institute at Moscow. This paper gives in brief the story of the broods during one season, which is as follows: The larvæ of the spring generation were numerous, and the greater portion of these transformed to the puparium stage toward the end of May. In the first half of June a number of puparia transformed to true pupæ, but the principal portion (about 70 to 80 per ct.) remained in the puparium stage until the latter half of August, when under the influence of rain, the development was completed. That this was a case of retardation due to high temperature and a dry season was proved by removing the puparia from time to time during the summer to cool, moist conditions; from whence adults emerged in two weeks. This same fact was proven by Marchal and is now said by Webster (U. S. D. A. Ent. Cir. 70, p. 11) to occur regularly in the southern part of the United States.

while others show seasonal behavior although conditions for growth obtain. To what extent the hibernation and retardation behavior in *P. brassicæ* are affected by an internal response cannot be stated. Our studies were directed to determining the influences of different elements of the environment upon the life of the pupa, and no evidence was accumulated to show how various factors in the surroundings of the larva may affect pupal development. It is believed, however, that the conditions surrounding the nearly mature larvæ may influence in an important way the later development of the pupæ.

SUMMARY OF EXPERIMENTS TO DETERMINE EFFECTS OF MOISTURE AND TEMPERATURE ON RATE OF DEVELOPMENT OF PUPA.

1. Differences in soil moisture within wide limits do not alter the length of the pupal period after development has begun.

2. A marked deficiency of moisture, alone or with high temperature also, retards development.

3. A high temperature, such as frequently occurs during the summer months in western New York, is unfavorable to normal growth, and seems to cause a retardation in development which may last until low temperature returns.

4. When the conditions are severe or unfavorable, the individual pupæ respond differently to the same environment. Thus, certain pupæ may finish their development in a shorter time than usual when subjected to a high temperature, while others may æstivate for an indefinite period.

5. Some data has been accumulated to show that a normal period results for a large percentage of the pupæ when optimum conditions for this species obtain.

NATURAL ENEMIES.

Aside from hot, dry weather which is very unfavorable to the insect, and is probably the most formidable factor against its development and propagation in this region, the cabbage maggot has a number of natural enemies, chief among which are certain staphylinids of the genus *Aleochara*, a cynipid parasite, *Pseudoeucoila gillettei* and a mite, *Trombidium* sp.

If the theory proposed elsewhere be accepted, that *P. brassicæ* was brought into this country in the pupa stage in soil used as ship ballast, or was introduced by means of infested root crops, such as turnips, then it would appear that the various European enemies which attack the larva and pupa stages would probably be imported in the same way.

Perhaps of most importance as an enemy of the cabbage maggot in this community is the staphylinid, *Aleochara bipustulata* L. This species, which was once thought to be both predaceous and parasitic, has been discussed in literature under the names *nitida*, *verna* and *anthomyiæ*. The insect was named *Aleochara nitida* in Germany in 1802. Specimens collected in Missouri were described by Say in 1836 as *Aleochara verna*. In 1869 *verna* was made a synonym of *nitida* by LeConte; but there seems to be some doubt as to this classification as *verna* has been recently listed by Fenyes [1] as a distinct species. The insect was bred from pupæ of *brassicæ* in 1870 by Sprague, and in 1880 Barnard found the parasite very numerous in Ithaca and observed the adults feeding upon *brassicæ* larvæ. In 1890 the beetle is mentioned by Fletcher. It is also recorded by Washburn [2] as having been found in Minnesota.

Recently Wadsworth [3] of Manchester, England, has published the life history of a staphylinid parasite of the cabbage maggot under the name of *Aleochara bilineata* Gyll. He states as a reason for adopting this name that of a number of beetles reared from puparia only one agreed with the description of *A. nitida* while the others were regarded as belonging to the variety *bilineata* Gyll., of *A. nitida*. This variety differs from the type form in having no red spots at the apex of the elytra, which are shining black. Wadsworth states that the young of this insect hatch from the eggs as free living staphylinid larvæ, after which they enter the puparia of the cabbage fly to feed upon the pupæ and that they undergo a simple form of hypermetamorphosis as a result of their parasitic mode of life. He states that there are two generations about Manchester, England; the adults of the first generation emerging in May and June and those of the second generation in August and September. Ten to twenty-five per ct. of the puparia examined by Wadsworth were infested by Staphylinidæ.

[1] *Ent. News*, 19:64. 1908.
[2] Minn. Agr. Exp. Sta. Bul. 112, p. 204, 1908
[3] *Jour. Eco. Biol.* Nos. 1 and 2, 1915.

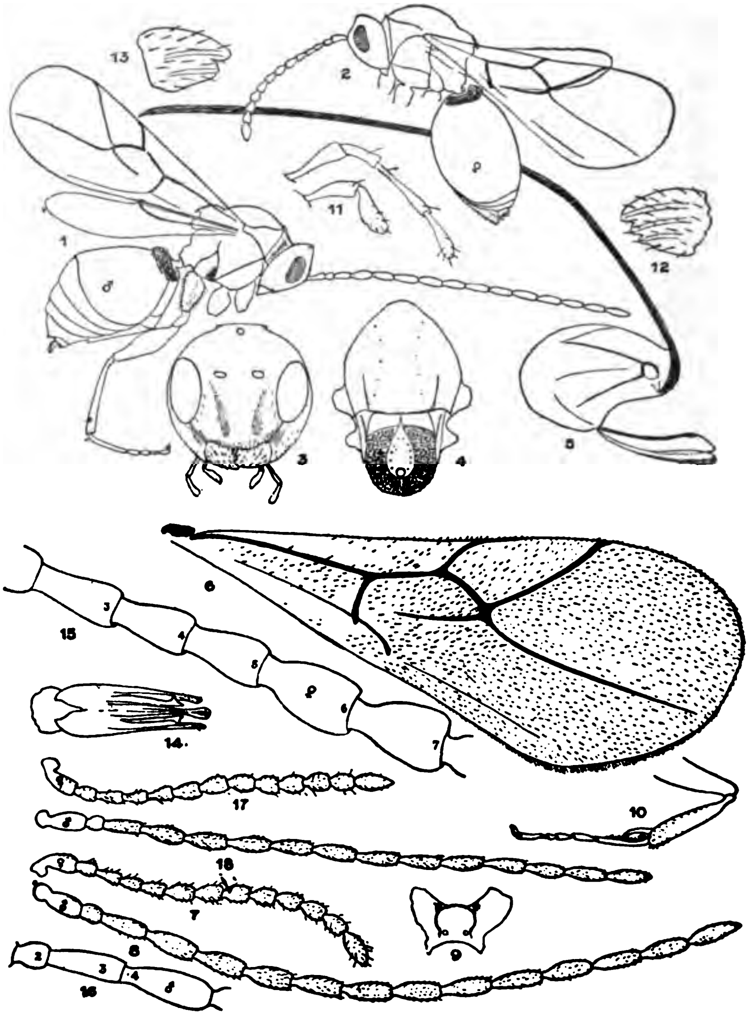

FIG. 13.—STRUCTURAL COMPARISONS OF *Cothonaspis rapæ* AND *Pseudoeucoila gillettei*.

1, Male of *C. rapæ* (West.). × 10; 2, Female of *C. rapæ* (West.) × 10; 3, Head of male × 22.5; 4, Mesonotum and scutellum of female × 22.5; 5, Ovipositer × 22.5; 6, Front wing × 22.5; 7, Antenna of female × 22.5; 8, Antenna of male × 22.5; 9, Prothorax of female showing truncation × 22.5; 10, Tibia and tarsus of front leg × 22.5; 11, Maxillary and labial palpi of female × 50; 12, Right mandible of male × 50; 13, Left mandible of male × 50; 14, Reproductive apparatus of male × 37.5; 15, Segments 3–7 of female antenna × 75; 16, Segments 3–4 of male antenna × 37.5.

(From specimens bred from puparia of cabbage maggot, *P. brassicæ*, by Mr. J. T. Wadsworth, Northenden, England. The material was preserved in alcohol, the parts were mounted in balsam, drawings were made with a camera lucida.)

17, Antenna of a female (*P. gillettei*) bred from a puparium of cabbage maggot at Geneva, N. Y.; 18, Antenna of a male (*P. gillettei*) bred from a puparium of cabbage maggot at Medina, N. Y.

(Drawings by L. H. Weld.)

In our work at Geneva we have frequently bred staphylinids (Plate XLI, figs. 3 and 4) and have found them in such numbers about injured cabbage and radish plants as to leave no doubt as to the nature of their activities or their importance. In addition to *bipustulata* we have occasionally bred *Philonthus nigritulus*,[1] and *Homalota sordida*. We have taken the following species near infested cabbages, *Tachyporus jocosus*, an unknown *Aleochara* sp. allied to *athata*, *Oxytelus nitidalus* and *Staphylinus badipes*.

From a review of the literature of the cabbage maggot, it seems safe to conclude that some of the staphylinids that attack the insect in Europe are also present in America. Our studies also indicate that there are a number of species of staphylinids, native as well as of foreign origin, that are predaceous upon the cabbage maggot.

Another important parasite is the cynipid species, *Pseudoeucoila gillettei*[2] Ashm. (Plate XLI, figs. 1 and 2). This insect has been recorded by Washburn and Webster in Minnesota and by them is called the principal parasite. The insect was bred in considerable numbers by Webster[3] who prepared a table showing the period of emergence of the parasite as compared with that of the host. Of the individuals of this lot of pupæ 36.6 per ct. were parasitized. In our studies of the cabbage maggot about Geneva the adults of *P. gillettei* have frequently been bred and the adults have now and then been collected in crevices in the soil about the roots of infested cabbage.

In the accompanying table are the results of a series of collections made in a screened seed-bed on the Station grounds. These results are interesting, as they tend to corroborate Webster's observations. It is very probable that had later collections been made the total percentage of flies to parasites would have been materially changed.

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[1] Determinations of the species of Staphylinidæ were kindly made by Major Wm. T. Casey.

[2] This species was identified by Mr. L. H. Weld, Evanston, Ill., who reports that the insect has also been reared from the cabbage maggot at Port Townsend, Wash., Medina and Carlton Station, N. Y., and Trenton, N. J. The fact that the cabbage maggot is an introduced species suggested the possibility that the parasite is also of foreign origin. Comparison of specimens with *Cothonaspis octotoma* Thomas and *C. rapæ* West., obtained from Europe, led Mr. Weld to believe that the cynipid in question is closely related to if not identical with *rapæ*. The insects show great similarities, even in antennal characters, Fig. 13, but owing to some slight differences, due perhaps to methods of mounting, it seems best to regard them as distinct species until the types may be examined.

[3] Minn. Agr. Exp. Sta. Bul. 112, p. 207, 1908.

TABLE XV.— RELATIVE ABUNDANCE OF *Phorbia brassicæ* AND *Pseudoeucoila gillettei*.
(Adults of two insects collected from screened cabbage bed, Geneva, N. Y., 1909.)

	Aug. 27.	Aug. 31.	Sept. 4.	Sept. 7.	Sept. 12.	Sept. 15.	Sept. 20.
P. brassicæ......	27	24	29	15	6	7	2
P. gillettei......	2	......	......	2	3	6	12

The cabbage fly has another enemy, a mite that attacks its eggs. The mite was first recorded by Gillette [1] who found that three mites would destroy an average of twenty-eight cabbage maggot eggs in a day. Washburn records another species *T. scabrum* Say in Minnesota [2] and Smith [3] found both *T. sericeum* and *T. scabrum* abundant about cabbage plants in New Jersey.

Trombidium sericeum [4] has been observed each season about cabbages in the vicinity of Geneva. The mites have always been in evidence during the oviposition period, and frequently several individuals were found about one plant. In one small field we have known, during the height of the egg-laying period, more than two hundred eggs per day to have been deposited by the adults of the cabbage maggot about plants and yet because of the activities of the mites with perhaps the assistance of other enemies young cabbages have in spite of abundant oviposition escaped with only slight injuries.

In addition to the foregoing species, mention has been made of a number of other enemies of doubtful importance. Washburn bred a number of hymenoptera and collected some carabids which were thought to be predaceous on cabbage maggots. He observed the following species of beetles feed on larvæ in the laboratory, *Pterostichus coracinus*, *P. leucoblandus*, *Agonoderus pallipes* and *Amara impuncticollis*. During the progress of our studies we have collected three common species of ants [5] that appeared to be predaceous; *Stenamma brevicorne* Mayr. was collected while transporting

[1] *Can. Ent.* 20:133, 1909.
[2] Minn. Exp. Sta. Bul. 100, p. 8, 1906.
[3] N. J. Expt. Stas. Rept. '08, p. 351; '09, p. 381.
[4] The mite was determined by Nathan Banks through the kindness of Dr. L. O. Howard of the U. S. Bureau of Entomology.
[5] The ants were named by Dr. W. M. Wheeler of Bussey Institution, Harvard University.

cabbage maggots; *Formica fusca* L. var. *subsericea* Say carrying an adult of *P. brassicæ*, and individuals of *Solenopsis molesta* Say were captured while conveying eggs and small larvæ. In addition individuals of *Lasius niger* L. var. *americanus* Emery have sometimes been very abundant near badly injured cabbage plants. We have observed the carabid *Clivina impressifrons* in the earth about infested cabbage plants for the past several years.

PREDACEOUS ENEMIES OF THE ADULT.

No enemies have been mentioned of the mature stage of *P. brassicæ* and the only positive evidence that we have that the flies are subject to attack by predatory forms is that we have occasionally collected adults with red mites attached to the under sides of the bodies. On one occasion an anthomyid[1] (*Cœnosis flavifrons* Stein) was collected that attacked and killed adults of *brassicæ*. The predaceous habit of this fly was discovered August 23, 1911, when one individual was observed standing over an adult of *brassicæ* with its beak inserted into its neck. After sucking for a few moments the victim was turned on its back and the beak inserted in the under side of the abdomen. The fly *flavifrons* killed eight other adults in a period of about eighteen hours. A few females of *brassicæ* have been found that appeared to have been killed by a fungus and this in one case was determined by F. C. Stewart of this Station as *Empusa* sp. This last agency is certainly not important, or its effects would have been more frequently observed. As the adults of *brassicæ* hide a large portion of the time among weeds and in the loose leaves of cabbage, they are doubtless preyed upon by many species of spiders.

EXPERIMENTS FOR THE CONTROL OF THE CABBAGE MAGGOT.

DESTRUCTION OF ADULTS BY POISON BAIT.

In South Africa where the fruit fly, *Ceratitis capitata*, is very injurious, C. W. Mally[2] tested among other remedies the use of poisoned bait. He found that a very light sprinkling over the trees of a mixture consisting of sugar, arsenate of lead, and water almost completely controlled the pest. More recently Illingworth[3] states

[1] The species was determined by Dr. P. Stein, Treptow, Ger.
[2] *Exp. Sta. Record.* 21:655, 1909.
[3] Cornell Exp. Sta. Bul. 324:164, 1912.

that adults of *Rhagoletis pomonella* feed readily upon sweetened mixtures and that death occurs in a few minutes when soluble arsenic is used. In addition to the various methods of eradicating the house fly, such as removal of waste, etc., Prof. C. F. Hodge of Clark University, Worcester, Mass., proposes to attract and capture the hibernating adults by means of mechanical devices in April before they are sexually mature. As only a small percentage of house flies survive the winter, and a period now thought to be ten to fourteen days is required for sexual maturity, many individuals may be captured by the so-called fly traps before oviposition occurs.

As stated elsewhere it is believed females of *P. brassicæ* require a period of three to five days to become sexually mature, and if it were possible to entrap or destroy them during this interval later injury would doubtless be avoided in proportion to the numbers of flies destroyed.

After the fondness of the adults of *P. brassicæ* for sugar water had been learned experiments were made with combinations of sweetened water and arsenic. Flies confined in lantern globes appeared to feed with the same relish upon poisoned water as that containing no poison. In general one and one-half to two days were required for arsenate of lead to cause death, while more soluble forms of arsenic were frequently effective in less than two hours.

During the season of 1913 an effort was made to determine whether or not a seed-bed could be protected by the use of poisoned bait. The formula used in the preparation of the bait is that recommended by Mr. Mally which is as follows:

Cheap molasses	2 pounds
Paste arsenate of lead	3 ounces
Water	4 gallons

Three applications of this mixture were made to a seed-bed during the oviposition period.

The adults of *brassicæ* present in this seed-bed were very closely observed, following the application of the poisoned bait. They seemed to be slightly attracted to the spray before it dried, but decreasingly so thereafter. Following each application some of the adults which were observed to feed upon the droplets of spray were captured and taken to the laboratory for observation. These flies

lived two weeks or longer and were apparently not affected by the poison. It was not possible to tell whether the treatment of arsenate of lead affected the numbers of eggs deposited. The negative results obtained in the above experiment suggested tests with potassium arsenate instead of lead arsenate in preparing the poison bait. Accordingly some poison bait containing potassium arsenate was sprayed on weeds and grass immediately adjacent to a cabbage seed-bed and shortly after some flies were taken in the act of feeding upon the poison spray, all of which died within an hour.

While the efforts to prevent oviposition by the destruction of the flies have in the main been unsuccessful, our field observations and laboratory experience taken together indicate that some protection could be obtained by attacking the insect in the adult stage. In the laboratory the adults feed at any time upon sweetened water. In the field the females have repeatedly been taken between 7:30 and 9 A. M. at droplets of dew. If poisoned bait were distributed in a field, undoubtedly many individuals would be destroyed before becoming sexually mature. Also it seems probable that the use of arsenic for cabbage worms as sometimes practised would destroy some of the adults.

CAPTURING ADULTS WITH STICKY FLY PAPER.

During 1910 tar paper disks or pads, to which a ring of tanglefoot had been applied, were placed about ten cabbage plants that had been transplanted several weeks and were of good size. The results as measured by the number of entrapped flies, were so satisfactory that other tests on a larger scale were made that season and again during 1912. In these tests as before adults of *brassicæ* were captured, but as a result of cultivation and wind the sticky surface of the pads soon became covered with dust and ceased to be effective. For this reason the plants about which the disks containing sticky material were placed were no better protected than other plants provided with untreated paper collars. Mention is made of these efforts to call attention to the fact that adults of *brassicæ* were entrapped by the means described. With a material capable of maintaining suitable sticking qualities under field conditions, tar pads could unquestionably be rendered more effective than as ordinarily used.

CHEESECLOTH SCREENS FOR THE PROTECTION OF CABBAGE SEED BEDS.

For many years farmers in various sections of western New York have found it almost impossible to grow cabbage seedlings. Flea-beetles attacked the leaves of the young plants as soon as they appeared above ground and immediately thereafter the flies of the cabbage maggot deposited their eggs, from which the destructive larvæ promptly emerged to attack the seedling plants at the root (Plate XLII). The only means adopted by growers to overcome the work of these insects was to secure plants from without the State, or to sow large quantities of seed at varying intervals of time with the hope that some of the beds would escape injury.

In 1906 and 1907 several control measures were given thorough trials at Seneca Castle, and during the latter year various protective coverings, such as wire screen and cheesecloth were tested. The object in employing screening was to prevent the flies from ovipositing about the plants. The cheesecloth had been previously tried by local growers, but with very indifferent success as the frames were not tight. In the first experiments by this Station care was used to make the frames fly proof with the result that protection from the maggots was perfect (Plate XLV). It was also shown that injury by flea-beetles was largely avoided. The tests with cheesecloth have been so satisfactory and conclusive that this method of protecting seed beds has been adopted generally by cabbage growers for at least a portion if not all of their seed beds.

The experiences of farmers about Seneca Castle during more recent years have corroborated the work of this Station and have clearly shown that the use of tight frames covered with cheesecloth of 20 to 30 threads to the inch will entirely prevent injury by the cabbage maggot, and reduce the extent of injury by the flea-beetle. In addition to protection from the foregoing insects cheesecloth helps to conserve the moisture and prevents the soil from becoming incrusted. Plants raised in screened beds grow faster during most seasons and attain the size desired for transplanting sooner than plants in open beds. A survey[1] of farms about Seneca Castle showed that the extra cost of protecting plants by this method

[1] N. Y. Agr. Exp. Sta. Bul. 334, 1911.

ranged from six to twenty cents per thousand, and in the opinion of many of the growers this additional outlay is more than met by the saving in seed over the old method of growing seedlings.

PROTECTION OF EARLY CABBAGE.

For many years truck gardeners and farmers in certain localities who make a business of growing cabbage for the early market have been unable to protect their plantings from root maggots. As our studies have shown, the growth period of the early cabbage and the production and development of the first brood of maggots are coincidental, so that each year a percentage of the crop, sometimes more and sometimes less, is liable to be ruined or so retarded in its growth as to spoil its value for the early market.

To control the injurious activities of this insect many remedies have been recommended, some of which have been tried by truck gardeners with a degree of success, but no measure has been generally adopted for the protection of early cabbage fields. As opportunity afforded preliminary tests were made by this Station of a number of the more promising control measures generally recommended. Among the measures tested, the two that stood out as being most successful as well as most practical were carbolic acid emulsion, as a liquid soil insecticide, and tar paper disks. Field experiments were then planned to test these measures on a commercial scale. The results of these tests may be briefly summarized as follows:

Carbolic-acid emulsion.— Laboratory tests with the material demonstrated that a mixture containing .33 per ct. crude acid would prevent the eggs from hatching and was fatal to the larvæ of the first and second instars and to some of the recently moulted individuals of the third instar. However, when the carbolic-acid emulsion was tested in the field it was found to be injurious to tender seedlings. Approximately 50 per ct. of the treated plants died, and the remaining plants were much retarded. Cabbage plants which had been transplanted several weeks and were well established showed no ill effect of the treatment. A serious objection to this method of treatment is that in actual practice truckers do not apply the emulsion until the injurious work of the maggots is in an advanced stage, and plants are damaged beyond recovery.

Tests with tar pads.— For a number of years cooperative experiments have been conducted by this Station with a number of truck

growers near Geneva in order to test tar paper disks for the protection of their plantings of early cabbage against root maggots. These experiments[1] have shown that the employment of tar pads is an efficient method of reducing losses to early cabbage from the insects. The actual amount of protection secured by this means has varied with different farms according to the severity of the attacks by this pest, but in plantings where the maggots were abundant and very destructive a large percentage of the plants protected by the disks have produced marketable heads (Plate XLVI). In addition to reducing the number of plants killed by the insects another important result of the experiments should be noted, that the tar pads have largely prevented root injury, which, though not sufficient to kill the plants, may be extensive enough to retard growth, so that the crop fails to reach the earliest market when usually the highest prices prevail. The cost of protecting cabbages by this method ranges around $1.40 per thousand plants, which is a small item when compared to the usual price of early cabbage.

METHODS OF CONTROL.

SCREENING FOR THE PROTECTION OF SEED-BEDS.

In localities where the injury is confined to the seed-bed the use of cheesecloth is a practical and economical means of preventing loss. It is well also to point out that in some years injuries by maggots are supplemented by flea beetle work. These insects attack the seedlings just as they appear above ground and frequently destroy the entire crop. Their work has been discussed with that of the cabbage maggot in Bulletin 334 from which the following directions, for screening of seed beds as a means of protection against both pests, are copied.

SUGGESTIONS ON SCREENING.

The seed-bed should be located on a fertile, well-drained soil, where there can be no accumulation of water or washing under the frame by rains. It is also desirable to locate the bed on land known to be free from weeds, and injurious insects such as wire worms and white grubs. The ground should certainly be free from the disease known as club-root. The soil should be thoroughly cultivated so that it is in good physical condition at seeding

[1] N. Y. Agr. Exp. Sta. Bul. 382, 1914.

time. It is customary to apply liberal amounts of high grade commercial fertilizer. The seed should be drilled rather thickly, in rows six or eight inches apart. When the early varieties of cabbage are to be grown, the seed should be planted during the first part of May or even earlier, whereas such varieties as Danish should be planted about May 15th. Before the seed is drilled, the corners of the bed should be staked, so that the frame can be built and the cheesecloth applied before the plants come up. This is important as the cloth prevents the soil from baking and conserves the moisture; also if the screening is delayed until after the plants come up, the plants are subject to injury by the flea-beetle. Six-inch boards will serve for the frame though some growers use eight and ten-inch boards with satisfaction. The cloth should not sag and rest on the plants. This may be prevented by stretching several lengths of wire from end to end of the bed. The wires should not be more than four or five feet apart. The wire can be supported on stakes to which it is held by staples. It is preferable that galvanized wire and staples be used as rusty wire wears holes in the cloth at the point of contact. All openings under the frame, due to unevenness in the soil, should be filled by banking the earth against the boards. To harden the plants so they will not wilt beyond recovery when set in the field, the cheesecloth should be removed a week or ten days before transplanting. It is well to examine the soil about the plants at intervals of several days after they have been uncovered to ascertain if eggs are being deposited. If the eggs are numerous the plants should be transplanted as soon as possible, the earth being shaken from the roots, which will dislodge most of the eggs or young maggots. When the plants have reached a desirable size they should be transplanted, as they are liable to grow too long and spindling.

TAR PADS FOR PROTECTING EARLY CABBAGE.

The value of tar pads or hexagonal tar-paper collars for the purpose of preventing the adult of the cabbage maggot from placing eggs about the stems of the plants has been well demonstrated in experiments discussed in Bulletin No. 382 of this Station. The tests described show that tar pads will protect early cabbage at a small cost. Growers who are troubled by this insect are urged

to test this method on their own plantings. The directions for applying the protectors are given in detail in the foregoing publication and are briefly as follows:

Truckers who intend to use tar pads to protect their cabbage plants should arrange to transplant seedlings of good size with rather long stems. It is impracticable to adjust the disks about small plants especially where only the leaves protrude above the soil. To secure the greatest benefit the tar papers should be applied immediately after the work of transplanting, so that the flies will

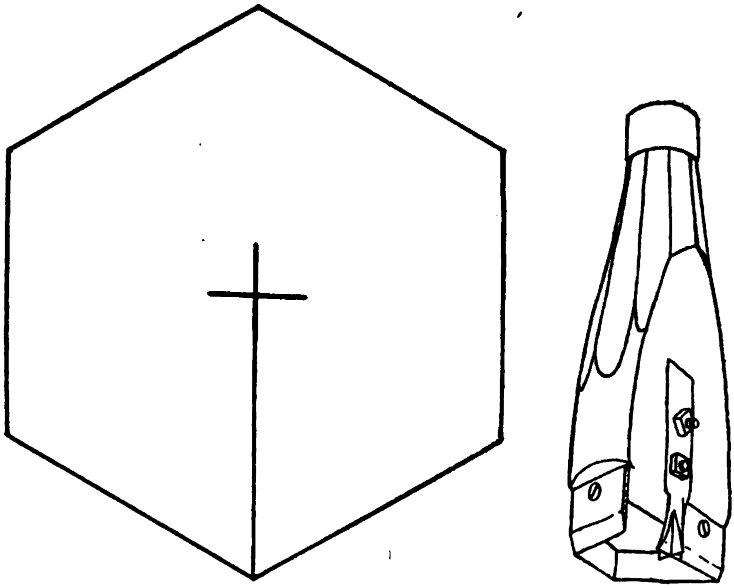

FIG. 14.— TAR-PAPER PAD AND TOOL FOR CUTTING.

not have an opportunity to oviposit about the plants. To adjust the pad, separate the two edges of the slit running to the center, slip the card around the stem of the plant and press it firmly against the soil so that it fits snugly about the stem and the radial opening is closed. It is preferable that the tar pad should be slightly above or at least level with the surface of the soil, so that it will not become covered with soil during the first washing rain.

The cards are cut in the shape of a hexagon from roofing paper known as "single-ply tarred-felt." They may be purchased or cut at home with the tool shown in Fig. 14.

FARM PRACTICES TO PREVENT MAGGOT INJURY.

The cabbage grower can reduce losses by the cabbage maggot by the destruction of crop remnants at all seasons of the year, and by not growing turnips or other succulent cruciferæ in the autumn. There are at least two broods of the insect that are numerous every year; one in the spring that infests cruciferous weeds, radishes and early cabbage, and one during September and October that depends for its food supply upon crop remnants, turnips and other field crops. As a general rule the work of the fall brood of maggots is unnoticed because the creatures feed largely on sprouted cabbage stumps or on some field crops, the value of which is not seriously lessened. The spring brood of maggots attacks early cabbage and seedlings of late cabbage at a time when they are most susceptible to injury. This brood does much damage and is the cause of considerable apprehension during some seasons by growers of these vegetables.

The numerous collections that we have made about turnips, cabbage stumps and other remnants indicate that the flies that emerge in the spring are to a large extent the adults of the fall brood of larvæ. In other words, the presence during the autumn of a large acreage of succulent cruciferous roots, furnishes food for great numbers of maggots which emerge as adults the following spring to infest radishes, early cabbage, etc.

Any measure therefore that will lessen the amount of this succulent food, such as removal of the crop remnants, will tend to reduce the numbers of maggots that develop in the fall and consequently the number of insects the next year. From an entomological standpoint it would appear desirable after the cabbage crop is removed to plow under the stumps or allow sheep to have the run of the field. In communities where the injury by the cabbage maggots is very severe, present evidence indicates that swedes, turnips and other late cruciferous crops shall as far as possible not be grown.

Another practice that has given good results in the production of seedlings for the late crop of cabbage is the growing of the seedling plants outside of the cabbage growing community. A number of large cabbage growers about Geneva and Seneca Castle, have at times arranged to have their seedlings grown several miles or at a greater distance from their own farms. As a means of obtaining seedlings free from injuries by the cabbage maggots and at a reasonable cost this practice has proven very successful.

THE LEAF-WEEVIL.*

(*Polydrusus impressifrons* Gyll.)

P. J. PARROTT AND H. GLASGOW.

SUMMARY.

The leaf-weevil (***Polydrusus impressifrons*** Gyll.) is an imported species from Europe which was discovered in 1906 in the State of New York, where in certain localities it has become very abundant. The beetle feeds on a large variety of plants, apparently manifesting a choice for willows, poplars and birches. In its native habitat the insect has attracted only slight attention and its life history and habits are not fully understood.

The insect is a snout beetle, light metallic green in color and about one-fifth of an inch in length. The adults emerge from the ground during May and early June. Oviposition begins soon after the appearance of the beetles. The eggs are deposited under loosened bark on dead stubs or about wounds due to pruning or scars in the bark resulting from hail injury or attacks by insects. The incubation period averages about eleven or twelve days. The larva is a slender, legless, white grub which, when in a recumbent position, preserves a ventrally curved crescentic form. Upon hatching it seeks the earth, subsisting on the roots of plants. Pupation occurs in the spring. The species is single brooded.

As is characteristic of a number of species of the group to which it belongs, the damage by ***impressifrons*** is two-fold: It nibbles the developing buds of budded and grafted stock and attacks the foliage and succulent tissues, as stems of newly-unfolded leaves and stalks of terminal growth. The gouging of tender tissues is not infrequently attended by severing of leaves and destruction of tips of shoots.

The leaf-weevil is subject to attack by at least one natural enemy. This is a braconid which has been determined as a new species of the genus ***Diospilus*** Haliday. During recent years the parasite has been quite abundant and apparently is exerting an important repressive action on its host, although it does not yet exist in sufficient numbers to keep the beetle in check.

Protection from the beetle is obtained by applications of arsenicals at standard strengths.

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* A reprint of Technical Bulletin No. 56, December, 1916.

INTRODUCTION.

The leaf-weevil (*Polydrusus impressifrons* Gyll.) is an exotic insect and a type of beetle that, by reason of its bud and leaf-eating propensities, is somewhat unusual among the pests of nursery and orchard trees. Owing to the great numbers of the species in certain areas in this State, and as knowledge regarding the species is very meagre and successful control can best be determined by a thorough understanding of its activities, the life history and habits of the leaf-weevil have received careful consideration. Besides affording a more satisfactory basis for an estimation of its economic status the studies herein described have also shown that the beetle is quite amenable to treatment.

RELATIONSHIPS AND NATIVE STATUS.

CLASSIFICATION.

The species which is the subject of this account belongs to the Rhynchophora, a division of insects which includes those beetles popularly designated as curculios, weevils, bill-bugs and snout-beetles. No group of beetles is more strongly differentiated and distinct. The most striking structural character is the so-called snout or bill, which is a prolongation of the front of the head. With some species this organ is slender and long, almost as long or longer than the body of the insect; in others it is stout and strong. The antennæ are attached to the snout, while the mouthparts are situated at its apex.

The snout beetles as well as the larvæ are plant feeders. The beetles are active creatures and obtain their subsistence by biting into the external surfaces of succulent tissues, as tender leaves, growing buds, etc., or by gouging plant structures with their snouts. The larvæ either live free in the soil, where they eat into delicate roots of plants, or exist buried in tissues which they tunnel and destroy. The larvæ of some species produce curling of leaves or galls or other distortions, and in such malformations the artificers reside.

The group contains a large number of injurious species; and foreign economic works, especially by European writers, usually devote considerable attention to them. Taschenberg[1] lists upwards of forty species, Henschel[2] refers to eighty or more forms, while Hess[3] deals with no less than thirty-eight species. As a rule American writers in the field of applied entomology have dealt to a much less extent with such insects, but there are in the United States some species of prime agricultural importance, as the plum curculio (*Conotrachelus nenuphar* Herbst.), the apple curculio (*Anthonomus*

[1] Taschenberg, E. L. Entomologie für Gärtner und Gartenfreunde. 1871.
[2] Henschel, G. A. O. Die Schädlichen Forst- und Obstbaum-Insekten. 1895.
[3] Hess, W. Die Feinde des Obstbaues. 1892.

quadrigibbus Say), the boll weevil (*Anthonomus grandis* Boh.) etc., which are usually included in standard treatises.

In his memoir dealing with the species injurious to fruit trees Zimmermann[4] divides the snout beetles according to their habits into four groups, which are as follows:

Group 1.— Larvæ live free in the earth and obtain their subsistence on plant roots and possibly in part from humus in the soil. The beetles live on fruit trees and injure them by boring into or by eating the buds or by nibbling of the leaves. In this class there are grouped species of the genera *Otiorhynchus* Germ., *Phyllobius* Schönh. and *Polydrusus* Germ.

Group 2.— Larvæ live between bark and wood and produce winding galleries filled with worm-dust after the manner of bark beetles of the family Scolytidæ (Ipidæ). To this group there belong species of the genus *Magdalis* Germ.; and some other genera as *Pissodes* Germ., *Hylobius* Germ., and others of importance to forest trees.

Group 3.— Larvæ live in fruits and pupate in the ground. In this division there are listed species of the genera *Balaninus* Germ., *Rhynchites* Schneider, and *Anthonomus* Germ.

Group 4.— Larvæ feed in the interior of buds, branches or in clusters of rolled leaves. In this group there are included species of the genera *Rhinomacer* Geoffr., *Rhynchites* Schneider, and *Anthonomus* Germ.

As will be observed, *Polydrusus impressifrons* belongs to Group I in this classification. Both the genera *Phyllobius* and *Polydrusus* contain beetles that are very similar in appearance, ranging in color from various shades of brown to bluish-green or yellowish-green in color. A number of species are regarded as noxious insects because of their habit of nibbling young opening buds, gnawing blossom structures, thus preventing fructification, and of feeding on tender foliage. European economic literature usually devotes quite a little attention to species of both genera. Judeich-Nitsche[5] discussed seven species of the genus *Phyllobius* and two species of the genus *Polydrusus*, while Des Gozis[6] catalogued twenty-one species in the genus *Polydrusus* alone as occurring in France. Species of horticultural importance that are frequently mentioned by foreign writers are *Phyllobius argentatus* L. on beech (Judeich-Nitsche) and on apple, pear and cherry (Hess); *Phyl. maculicornis* Germ. on apple, pear, cherry, plum, oak, hawthorn, sloe, maple, and nuts especially (Theobald).; *Phyl. pyri* L. on birch and oak (Judeich-Nitsche) and on woodland trees, apple and pear (Hess); *Phyl. oblongus* L. on grafted nursery stock (Ormerod), eating apple

[4] Zimmermann, Hugo. Die Obstbauschädlinge aus der Familie der Rüsselkäfer, pp. 1-20. 1905.

[5] Judeich, J. F., and Nitsche, H. Forstinsektenkunde, Vol. I, pp. 408-409. 1895.

[6] Des Gozis. Étude du Genre *Polydrusus*, Revue d' Entomologie, Tome 1, pp. 151-153. 1882.

blossoms (Theobald), on woodland trees, apple, pear, cherry, plum and apricot (Hess); *Phyl. viridicollis* Fabr. on beech, oak, willow, aspen, raspberry and pine (Judeich-Nitsche) and on strawberry and raspberry (Hess); *Phyl. calcaratus* Fabr. on alders and black currant (Theobald); *Polydrusus sericeus* Schall. on various woodland trees, apple, pear, cherry and plum (Hess); *Poly. mollis* Stroem and *Poly. micans* Fabr., while generally considered of lesser importance, are occasionally recorded as injurious species. Common as are these insects in the normal range of their distribution, their habits and life histories appear not in all instances to have been carefully investigated and there is, for most of the foregoing species, lack of detailed data dealing with their activities as shade-tree, woodland or orchard pests. Moreover, as illustrated by some of the above forms, the status of the beetles as distinct species has not been clearly indicated by economic workers, for which reason several of the insects have been discussed under several names.

ECONOMIC IMPORTANCE AND HOST PLANTS.

It will be noted that *impressifrons* is not listed among the more important species of this group of beetles. This fact constitutes an anomalous feature of this study for it appears that we are dealing with a beetle that has attracted little attention in its normal habitat, and strangely enough one also which proves to be the first of a group of destructive insects to become thoroughly established in the United States. Such economic writers as Judeich-Nitsche, Nördlinger, Kaltenbach, Hess, Reh and Theobald, while they discuss the injurious activities of a number of associated forms, make no reference to this insect. It has however attracted the attention of systematic workers as Schönherr,[7] Redtenbacher,[8] Des Gozis,[9] Schilsky,[10] Heyden,[11] Everts,[12] Kleine,[13] Bedel,[14] and others, who have listed the insect, its host-plants and the countries in which it occurs. Desiring to know more of the status as an injurious insect than was indicated in available literature, a circular letter, soliciting information on the creature, was sent to a goodly number of entomologists in the different countries of Europe. The apparent importance of the species may be judged from excerpts from several letters. According to Dr. Marchal[15] "the beetle is a common insect in France on willows and alders. It is of no importance and has never been regarded as a

[7] Schönherr, C. J. Genera and Species Curculionidum, 6:230. 1840.
[8] Redtenbacher, Ludwig. Fauna Austriaca, Die Käfer, p. 707. 1858.
[9] Des Gozis. Revue d'Entomologie, Tome I, p. 104. 1882.
[10] Schilsky, Julius. Systematisches Verzeichnis der Käfer Deutschlands. 1888.
[11] Heyden, Lucas von. Catalogue der Coleopteren von Siberien. 1895.
[12] Everts, J. E. Coleoptera Neerlandica, 2:583.
[13] Kleine, R. *Entomologische Blatter*, No. 4, p. 103. 1910.
[14] Bedel, Louis. Coléoptères du Bassin de la Seine, p. 243. 1885.
[15] Marchal, P. Letter of July 5, 1916.

destructive species." M. Caillol[16] writes "that the insect is extremely common in Provence, France. It occurs on bushes, hedges, and trees, especially of willow, poplar, alder, pine, hawthorn and oak and eats both buds and young leaves. It is evident that by reason of its habits the insect should be considered a destructive species, but its injuries have never been regarded as important." Zimmermann[17] says that "the insect is not very common in Austria or Germany and occurs on willow and alder." It should also be stated that Kleine[18] lists the hazel (*Corylus avellana*) as one of its hosts. Injuries to fruit trees appear not to have been recorded but Rebel[19] writes that the beetle feeds on pear. While the adult and some of its activities are well known, facts regarding the life history and habits of the larval and pupal stages appear to be meagre, which again suggest that the economic status of the species in its native haunt is not very important.

DISTRIBUTION IN NATIVE HABITAT.

The leaf weevil ranges over central Europe, which includes such countries as France, Germany, Austria, western Russia and northern Italy. According to Bos[20] the species may be observed in Belgium, although it seems not to be very abundant. It is apparently rare in Holland, and has been recorded by Everts[21] only from Middleburg. The insect is not known to exist in England, Scotland or Ireland or in any of the Scandinavian countries.

STUDIES ON THE LEAF WEEVIL.

DISCOVERY AND IDENTIFICATION.

The existence of the leaf weevil in the State of New York was determined by this Station during the summer of 1906 when it was observed in large numbers on poplars and willows in the vicinity of Geneva. The insect was most abundant then, as now, in nursery plantations, where in some instances the creatures literally swarmed over the plants, scarcely a tree being free of them. A circular letter was then sent to owners of nursery plantings and nursery inspectors respecting the discovery of the leaf weevil, which resulted in the forwarding to the Station a few days later of some specimens of the insect from a nursery in another part of Ontario County. These were sent by the nursery foreman, who reported that the beetle was injuring roses and apples. Subsequent efforts during this season estab-

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[16] Caillol, M. Letter of July 9, 1916, through the courtesy of Professor Eugène Guillaud, Marseilles, France.
[17] Zimmermann, H. Letter of August 7. 1910.
[18] Kleine, R. *Entomologische Blatter*, No. 4, p. 103. 1910.
[19] Rebel, H. Letter of July 6, 1916.
[20] Bos, J. Ritzema, Letter of July 6, 1916.
[21] Everts, J. E. Coleoptera Neerlandica, 2:583.

lished the fact that the leaf-weevil was already thoroughly established in several counties in western New York. As the insect was apparently an introduced species, and was not represented in entomological collections in this country, specimens were forwarded to Professor Alfred Giard, The Sorbonne, Paris, and to Dr. G. Horvath, The Hungarian National Museum, Budapest, who reported that the beetle was *Polydrusus impressifrons* Gyll., a species indigenous to Europe.

METHOD OF IMPORTATION.

As the leaf-weevil is definitely known to belong to the fauna of the Old World, the question naturally arises as to how the insect gained a foothold in the United States. From a knowledge of its life history, which is later discussed in detail, it seems likely that the creature was transported in either the larval or pupal stages in earth about the roots of foreign-grown trees. As is well known there are large importations into this country of trees of considerable size, which are packed with such care that the root system and surrounding earth are practically intact as when originally lifted from the ground. With choice sorts of fruit and ornamental trees the balls of earth about the roots are often of considerable weight. As the insect hibernates as a larva and does not pupate until late in the spring, it is safe to conclude that the species could be brought to our shores in either of these stages in importations of nursery stock containing an appreciable quantity of the earth in which the plants were grown. This explanation seems plausible, considered either from the standpoint of the habits of the insect or the common practices of the nursery trade. It is less reasonable to suppose that the species was carried in the adult or egg stages since these occur during early summer, when importations of trees have ceased. In considering the ease with which *impressifrons* has been conveyed for such great distances, the wonder is that some of the associated leaf weevils which are more destructive have not been similarly introduced into this State.

DISTRIBUTION.

The leaf-weevil is common about Waterloo, Seneca County; Seneca Castle and Geneva in Ontario County; "Honeoye Falls[22] and Rochester Junction" in Monroe County, and Lyons in Wayne County. In these four counties it is thoroughly established and one experiences no difficulty in observing the species on its preferred hosts. Scattering numbers of the insect have been collected as far west as Albion in Orleans County. The beetle has also been reported[23] to us as occurring at Indian Falls, Batavia, Oak Orchard Swamp,

[22] Reported by Professor Cyrus Crosby and M. D. Leonard, Cornell University.

[23] Letter of July 18, 1916, from Charles W. Leng, New York City, giving the results of a collecting party, composed of himself, Wm. G. Davis, Staten Island, and H. H. Knight, Cornell University.

LeRoy and Portage. It is also deserving of record that while "the beetles were abundant in the Genesee Valley, not a specimen was observed at Conesus Lake which is just east of the Genesee River."

By means of correspondence attempts have been made to ascertain if the insect exists on Long Island and the eastern portion of the State but so far our efforts have been unsuccessful. The area of the known distribution of the leaf-weevil is shown in the accompanying map, but there is little question but that the insect exists over a much larger territory than is indicated. There is little definite knowledge

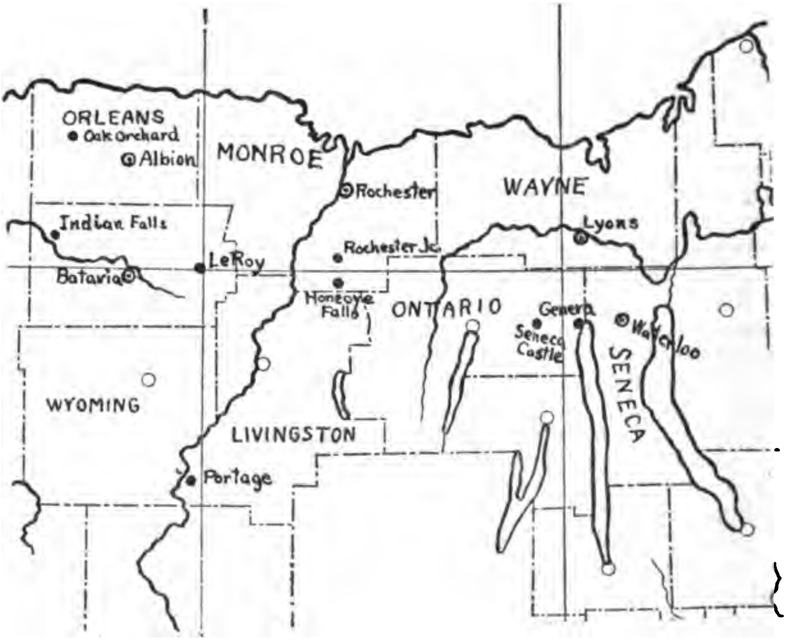

FIG. 15.—DISTRIBUTION OF LEAF WEEVIL IN NEW YORK.

of the occurrence of the beetle in other States but collections of the insect recently established the fact that it has secured a footing in Connecticut.[24]

DESCRIPTION OF LIFE STAGES.

Egg.— The egg (Plate XLVIII) is white, cylindrical and broadly rounded at the ends. Its shape may be changed by accommodation to other eggs and to surrounding surfaces. The contour of the egg is also rendered uneven by a mucilaginous substance adhering to it which is deposited at the time of oviposition. As the embryo matures the egg gradually becomes a light lemon yellow due to the color of the developing embryo. At this time the egg becomes slightly concave on one side as a result of

[24] Britton, W. E. 15th Rept. Conn. State Entomologist, p. 188. 1915.

the increased length of the larva, which just before hatching becomes bent, the head being directed toward the ventral side of the body. Under moderately high power the surface of the egg reveals a close network made up of a series of irregular corrugations. The chorion is a delicate white membrane that is easily ruptured by the larva in hatching. In this operation a hole is cut in the wall of the egg by the mandibles and then enlarged by the contortions of the larva. The eggs may occur singly but are usually deposited in masses, attached to the bark and to each other by threads of a white cementing substance. There is generally a fan-shaped series of these threads radiating from the position reached by the point of the ovipositor where this organ is projected beneath the bark. The number of eggs in a cluster is variable, ranging from a few to sometimes over one hundred. One mass from a three-year-old pear tree in a nursery row contained sixty-four eggs. The largest cluster observed, which was on white birch, was composed of one hundred twenty eggs. The average measurements of the eggs are: Length, 0.56 mm.; and diameter about 0.22 mm.

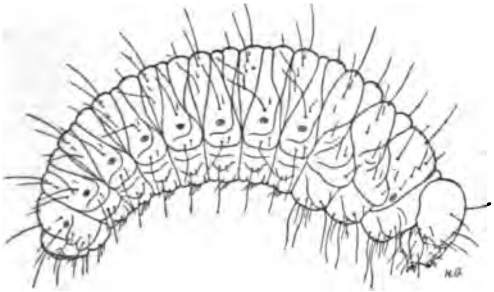

FIG. 16.— LATERAL VIEW OF LARVA. (Enlarged)

Larva.—At the time of hatching the larva is a slender, slightly flattened, legless grub which is covered with numerous long stiff hairs. The more prominent of the dorsal hairs are from 0.05-0.08 mm. long while those on the ventral side are much shorter. The larva is at first a light lemon yellow but soon changes to white except for the large light brown head which is supplied with a pair of prominent mandibles that are bi-dentate and of a somewhat darker brown color. The body is composed of thirteen segments, the ultimate segment being very much reduced in size and bearing fewer hairs. The short, stiff hairs on the ventral side function as organs of locomotion, while the posterior end of the alimentary canal when everted serves as a sucker by which the creature is able to cling to surfaces that are comparatively smooth. Upon escaping from the egg the young larva, which is very active at this time, at once begins to crawl about and soon leaves the recess in which the eggs were placed. After reaching the open the larva almost at once falls to the ground where it buries itself in the first crack that it encounters. In a state of inactivity the larva is curved ventrally on itself, although not so strongly as in the later stages.

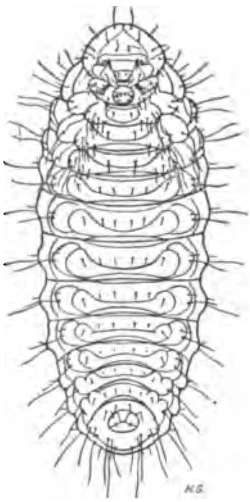

FIG. 17.—VENTRAL VIEW OF LARVA. (Enlarged.)

Length of newly-hatched larvæ varies from 0.72 to 0.80 mm. and the greatest breadth from 0.19 to 0.22 mm. The full-grown larva [25] (Figs. 16 and 17) is a legless, grub-like creature measuring from 4 to 6.5 mm. long and with a breadth of from 1 to 1.75 mm. It is white until shortly before pupation when it becomes slightly yellowish. The body is nearly cylindrical, the ventral side being somewhat flattened, and it tapers toward the posterior end, the greatest breadth being across the thorax. When at rest the body is strongly curved ventrally

[25] See also article by W. D. Pierce. *Jour. Econ. Ent.*, 9:424–431. 1916.

into a crescentic form. In the ground the larva is found within an oblong, earthen cell which is considerably larger than itself and from one to six inches below the surface.

The *head* is somewhat longer than broad, about .85 by .95 mm., light brown in color. Mandibles and epistoma dark reddish-brown, terminal segments also darker than general color of head. Epicranial and frontal sutures marked by light yellow lines. Labrum and submentum light yellowish or almost white. The minute, white, one-jointed antennæ are placed just above the base of the mandibles at lower end of frontal suture. Eyes are absent. Mandibles are strongly developed, with two blunt teeth; eight pairs of hairs on epicranium, one on front and one on epistoma opposite the antennæ; two pairs of large hairs on front of labrum with six pairs of smaller hairs on the lower margins. One prominent hair on front face of each mandible situated about two-thirds of distance from tip to base. On each of the maxillæ there are three large hairs on the stipes, one minute hair on the basal segment of the two-jointed palpus and ten on the inner edge of the lacinia, five of which are broad and truncate at the tips, being somewhat tooth-like in appearance. On the labium there are two pairs of hairs on the submentum, one large and one minute, and three pairs on the mentum, one large pair on the outer face in line with the two-jointed palpi and two, which are much more minute, between the palpi.

The *prothorax* bears a pair of large oblong spiracles, the long axis lying perpendicular to that of the body; the second and third thoracic segments are without spiracles; three pairs of large and six pairs of smaller hairs appear on the prothorax above lateral depressed line; the same number of hairs, although differently placed, on corresponding part of second and third thoracic segments. On each of the three segments below the lateral line there are two prominent fleshy lobes bearing hairs, two on the upper — one large and one small — and six on the lower, of which two are long and four are short. This applies to all three segments except that the smaller hair on the upper lobe is present only on the first segment. On the venter of each segment there is a single pair of short, spine-like hairs inclined to the rear.

The *abdomen* is composed of ten segments of which segments 1–8 bear spiracles. Hairs on segments 1–7 similar in number and arrangement. Beyond the seventh segment the arrangement of the hairs becomes more simple until on the tenth segment, which is reduced to four fleshy lobes surrounding the anal opening, there are but two pairs of minute, bristle-like hairs located on the lateral lobes. In the typical abdominal segments — segments one to seven — the dorsal and lateral aspects above the lateral depressed line may be divided roughly into three rather distinct lobes. From the side the anterior lobe is seen to bear but a single short hair on the dorsum. The middle lobe on which the spiracle is located carries two hairs, one long and one rather minute above the spiracle and two similar hairs below, while on the posterior lobe there is a series of five hairs, in a line extending dorso-ventrally, made up of three long and two much shorter units arranged alternately. Below the lateral line there are two fleshy lobes, the upper with two hairs, one long and one much shorter; the lower with but a single short hair similar to but slightly longer than the two pairs of short bristle-like hairs on the venter. On the eighth segment there are twelve pairs of hairs as against fifteen for the preceding segments, seven on the ninth and but two on the tenth. The ventral hairs on the ninth segment have been reduced in number to but a single pair, which are considerably longer than the corresponding hairs on the other segments.

Pupa (Fig. 18, p. 412).— Length 3–4.5 mm., breadth 1.5–2.5 mm. Color at first uniformly white. As pupa becomes older it gradually changes to a dingy yellow color. First the eyes, then the mandibles and later the tarsal claws become pigmented and show through the body wall, changing as the pupa becomes more advanced from a light pink to almost black shortly before the insect transforms to the adult. The small round spiracles are located on abdominal segments one to five, the first being concealed by the wing pad.

The head, thorax, legs, wing covers and to a less extent the abdomen are covered with very minute, erect, closely set hairs. The large, spine-like hairs are borne on more or less prominent tubercles, those located on the thoracic and abdominal segments being especially striking. On the head there is a pair of stout hairs on

PLATE XLVII.— LEAF WEEVIL: DORSAL AND VENTRAL VIEWS.
(Enlarged.)

Plate XLVIII.— Eggs of Leaf Weevil.
(Enlarged.)

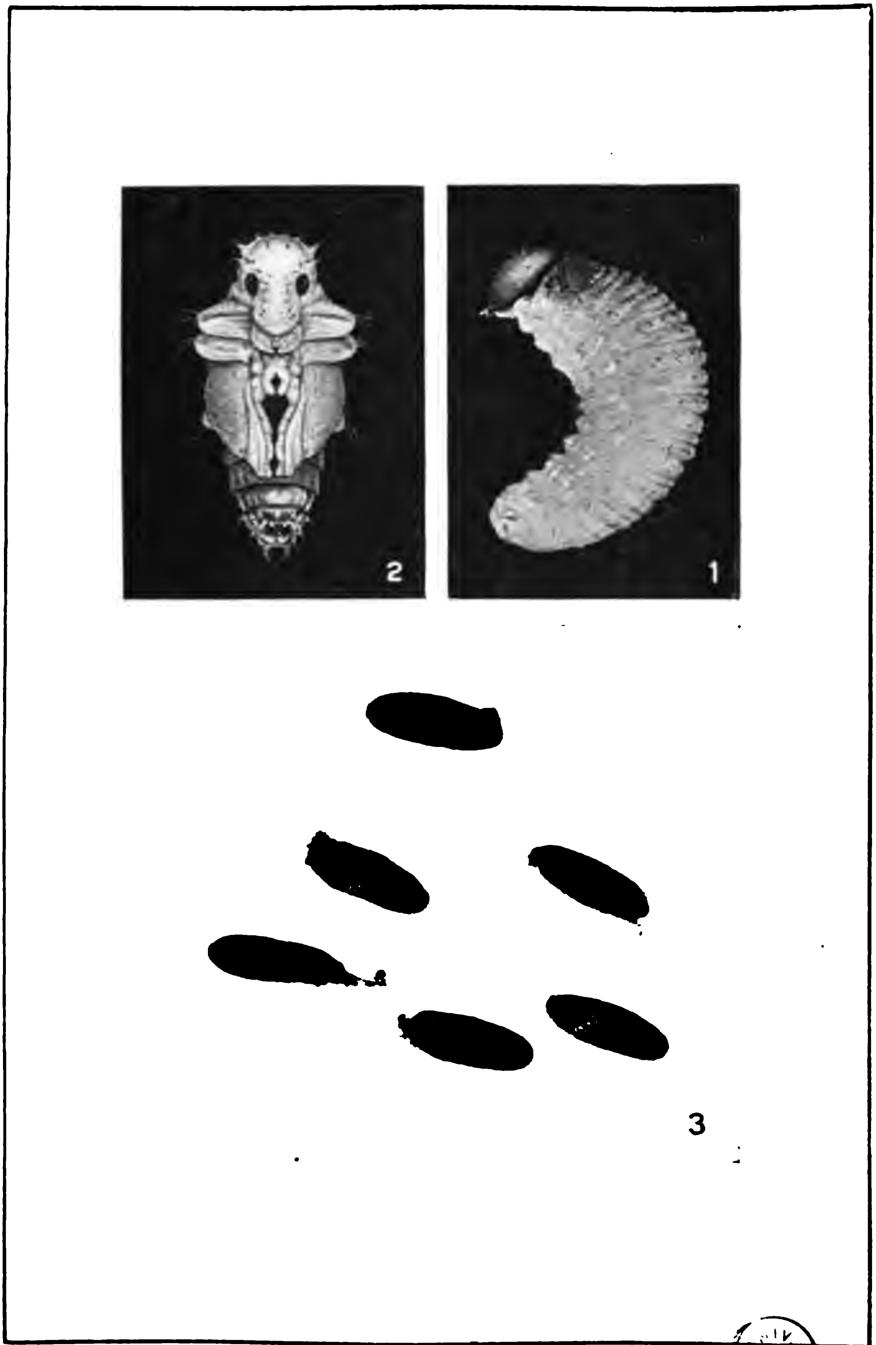

PLATE XLIX.— LEAF WEEVIL: 1, LARVA; 2, PUPA; 3, COCOONS OF PARASITE.
(Enlarged.)

Plate L.— Willow Leaves Eaten by Leaf Weevil.

Plate LI.— Poplar Foliage Showing Feeding by Leaf Weevil.

PLATE LIII.— LEAF WEEVIL: 1 AND 2, INJURIES TO WILLOW BUDS; 3, OVIPOSITION SITE; 4, BARK REMOVED SHOWING EGGS; 5, PORTION OF 4, MAGNIFIED.

PLATE LIV.— 1, INJURED LEAF CLUSTER OF GRAFTED WILLOW; 2, SEVERING OF NEW GROWTH.

the vertex, two more slender hairs directly above the eye, a single rather large hair above the eye at its inner angle and a series of four slender hairs in a line extending along the front of the beak. A short distance back from the tip of the beak there are two hairs, one small and the other minute, both arising from the same tubercle, while there is a single pair of very small hairs at the extreme tip of the beak. The prothorax bears nine pairs of hairs, four of which are rather small, the other five being very large and distinct. On the meso-thorax there are five pairs of hairs, one group of three on the dorsum — two large hairs with a smaller one between — and two smaller hairs at the base of each wing pad. On the third thoracic segment only the dorsal group of three is present. On abdominal segments there are five pairs of dorsal hairs, three very large with two smaller ones set between, while toward the front of the segment and above the spiracle there is one prominent lateral hair with a more minute one placed just posterior to it. On the eighth segment but one of the large dorsal hairs is present. The larger, lateral hair is also present. In addition to these there are four pairs of minute hairs which do not appear to correspond with those on the preceding segments. The ninth segment bears a pair of large curved spines projecting to the rear, a pair of minute dorsal and three very small lateral hairs. The legs have two long, curved hairs at the distal end of each femur.

Adult.—The adult (Plate XLVII) is a rather slender, uniformly light metallic green beetle, the color being due to minute scales which cover the entire insect with the exception of the legs and antennæ. Late in the season individuals are often observed which are considerably darker than normal. This variation is due to the green scales having been rubbed off in patches, exposing the dark colored body wall beneath. The males are noticeably smaller than the females, otherwise the two sexes are similar in general appearance.

Average size of male 4.25 mm. by 1.5 mm.; of female 5.5 mm. by 2.0 mm.

The insect was described[26] by Gyllenhal, the translation being as follows:

Femora muticous, oblong, black, fuscous-pubescent, densely covered all over with green scales which are generally distributed, antennæ and legs pale testaceous, rostrum very short, frons impressed.

Var. β. Color of scales more brilliant, greenish yellow.

Var. γ. Color of scales dark greenish blue.

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[26] Schönherr, C. J. Genera et Species Curculionidum, 2:140. 1834.

Femoribus muticus, oblongus, niger, fusco-pubescens, undique dense viridi — squamosus, antennis pedibusque pallide testaceis, rostro brevissimo, fronte impressa.

Polydrusus id. Dej. *Catal. Col.* p. 93.

* Var. β. Squamularum colore magis splendida, flavo — virescente.

Polydrusus sericeus, Germ. Ins. Spec. I, p. 452, No. 5 Teste Dom. Schuppel.

* Var. γ. Squamularum colore virescenti — coeruleo.

Patria: Gallia, Germania, Mus. Schh. et Ghl.

"*P. flavipedi* simillimus, ægre distinguendus, paulo tamen minor, pubescentia brevior et frons magis plana, sub-impressa. Caput majusculum, sub-quadratum, punctulatum, nigrum, dense viridi-squamosum, fronte inter oculos leviter impressa, cum puncto medio profundius intruso; oculi parvi, semi-globosi; brunnei; rostrum capite angustius et duplo brevius, similiter squamosum.

Antennæ thoracis basin fere superant tenues totæ pallide testaceæ. Thorax parvus, latitudine brevior basi apiceque truncatus, lateribus nonnihil ampliatus, supra parum convexus, intra basin et apicen leviter transversim impressus, punctulatus, niger, dense viridi-squamosus. Scutellum triangulare, viridi-squamosum. Elytra autice thoracis basi dimidio latiora, humeris elevatis fere rectangulatis, apice conjunctim acuminata, thorace sextuplo longiora, supra convexa, subtilius punctato-striata, interstitiis latis, planis; nigra, squamulis viridibus tecta et pubescentia brevi fusca adspersa; in insterstitiis striarum puncta parva, sparsa, nigra, denudata observantur. Corpus subtus punctulatum, nigrum, dense viridi-squamosum. Pedes validiusculi, toti pallide testacei, cinereo-pubescentes, ungulis saturatius brunneis.

Varietates colore squamularum tantum differunt."

"Very like to and distinguished with difficulty from *P. flavipes* nevertheless a little smaller, pubescence shorter and frons more flattened, sub-impressed. Head somewhat larger, sub-quadrate, punctate, black, thickly covered with green scales; frons between eyes lightly impressed, with deeper median puncture; eyes small, semiglobose, brown; rostrum narrower than head and half as long, similarly squamose.

Antennæ hardly extending beyond base of thorax, slender, wholly pale testaceous. Thorax small, narrower than the base and apically truncate, somewhat enlarged at sides, slightly convex on dorsum, within base and apex slightly transversely impressed, punctate, black, densely covered with green scales. Scutellum triangular with green scales. Elytra one-half wider than base of thorax, humeri elevated, almost rectangular, with apex conjunctly acuminate, six times longer than thorax, dorsally convex, finely punctate-striate, interspaces broad, flat; black, covered with little green scales and dotted with short, fuscous pubescence; in the interspaces of the furrows are observed small points, scattered, black and bare. Body beneath punctate, black, densely covered with green scales. Legs rather stouter, entirely pale testaceous, cinereo-pubescent, claws rather deep brown.

The varieties differ only in the color of the scales."

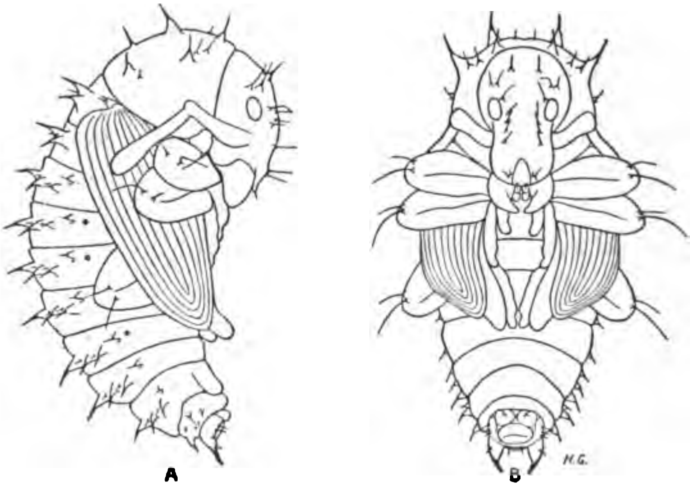

FIG. 18—LATERAL AND VENTRAL STRUCTURES OF PUPA.
(Enlarged)

FOOD PLANTS.

As is characteristic of many related species in their normal habitat the leaf weevil *impressifrons* may be observed on a large number of different kinds of trees. This fact would suggest that it is an omnivorous feeder, and observations indicate that it obtains subsistence to some extent on a goodly variety of trees, displaying at the same time marked partiality for certain plants which may be designated as preferred hosts. Among the trees in nurseries that are especially sought are birch, willow, poplar, apple and pear. To determine more closely the preferences of the insect beatings were made of these different plants and from the collections obtained it

appears that the beetle seeks birches, willows and poplars in the greatest numbers. If the leaf-weevil manifests any choice between any of these plants the selection would probably lie with the birch. In breeding cages the beetles feed on birch, pear, willow and poplar leaves with little evidence of any discrimination and always selected any of them in preference to apple foliage. Owing to the absence of alders no opportunity was offered to note the behavior of the leaf weevil toward this plant. Scattering individuals or occasional pairs in copula have been collected at various times on elm, linden, black locust, rose, hickory and black walnut, which in some instances appeared to have been feeding on certain of these trees, although their presence on them may have been accidental and due to the close proximity of more attractive plants. None or very few of the beetles have ever been observed on maple, box-elder, horse-chestnut, lilac, syringa, elderberry and various evergreens, although these plants were growing in considerable numbers near preferred hosts which were harboring leaf-weevils in great abundance. As previously noted the insect in its native habitat obtains its subsistence from willow, hazel, poplar, alder, pine, hawthorn, oak and pear.

OVIPOSITION HABITS.

Scars in the trunk and larger branches due to pruning and other causes, as hail and attacks by membracids and other insects, and similar mutilations of bark tissues are favorite retreats for the females for purposes of oviposition. In tiny crevices afforded by such situations many eggs are tucked away, completely concealed from view. Egg-laying also commonly occurs about scars or roughened areas in the bark formed by the sloughing off of dead twigs and branches. Ova have been observed on trunks of trees near the ground and at a height of ten feet with old trees. They doubtless occur at greater elevations. With nursery or young trees that are subjected to annual pruning the stubbed ends of twigs and branches are sought by large numbers of the beetles. As is known the tissues about the truncated ends of such wood frequently die, and with the loosening of the bark recesses develop between the bark and the wood core in which great numbers of eggs are deposited. As many as three and four insects have been observed on a small stub, all of which, with their dark extensile ovipositors thrust beneath the bark, were engaged in laying eggs. Under one tiny flap of bark in this situation as high as one hundred sixteen eggs were counted. In one instance the beetles were detected depositing eggs in dead branches that had been removed by pruning and which had been left on the ground as they fell. During the spring the buds made some growth before the wood dried, and, in addition to the usual positions for egg laying, the loosened bud scales showed abundant oviposition. On old trees eggs are frequently deposited beneath

rough, scaly bark on the trunks and branches. It appears from our observations that the insect is not very discriminating as to choice of location for the reception of the eggs as long as dry cavities in the bark, exposed to sunlight, exist into which the eggs may be pushed. (Fig. 3, Plate LIII.) In breeding cages devoid of wood the creatures oviposited freely in the soil, placing the eggs in cracks or chinks about small lumps of earth. The beetles were never observed ovipositing in this situation in the field, however, and as careful search failed to find any eggs in the soil it may be assumed that this is not of normal occurrence.

LENGTH OF INCUBATION PERIOD.

To determine duration of the incubation period, sections of poplar wood were placed in breeding cages in which were confined goodly numbers of beetles. The insects were allowed the use of the wood for about one day, when it was removed and examined from day to day to note conditions with respect to the hatching of the eggs. The records of four cages are as follows:

Cage I.— This cage was started at 4 P. M., June 9, 1914, and the beetles were allowed to oviposit on poplar wood for one day. The record of hatching is given in the accompanying table:

Date of Observation.	No. of Eggs.	Length of Period.
4 P. M. June 22	2	12 to 13 days
8 A. M. June 23	6	12 1/2 to 13 1/2 days
4 P. M. June 23	23	13 to 14 days
8 A. M. June 24 (all hatched)	19	13 1/2 to 14 1/2 days.

Cage II.— This cage was started at 4 P. M. June 17 and the beetles were permitted to lay eggs on wood until 8 A. M., June 18. The record of hatching is shown in accompanying table:

Date of Observation.	No. of Eggs.	Length of Period.
8 A. M. June 29	7	11 to 11 1/2 days
8 A. M. June 30	18	12 to 12 1/2 days
8 A. M. July 1	7	13 to 13 1/2 days
6 P. M. July 1	4	13 1/2 to 14 days
8 A. M. July 2 (all hatched)	8	14 to 15 days.

Cage III.— This cage was started at 8 A. M. June 19 and the beetles were permitted to lay their eggs on the wood until 6 P. M. of the same day. The record of hatching is shown in accompanying table:

Date of Observation.	No. of Eggs.	Length of Period.
8 A. M. June 30	15	10 1/2 to 11 days
6 P. M. June 30	24	11 to 11 1/2 days
8 A. M. July 1	50	11 1/2 to 12 days
6 P. M. July 1	35	12 to 12 1/2 days
8 A. M. July 2 (all hatched)	6	12 1/2 to 13 days.

Cage IV.— This cage was started on June 26 at 4 P. M. and on the following day at 11 A. M. the wood, on which the insects had oviposited, was removed from the breeding cage and placed in a cool shaded position out of doors on the north side of the laboratory. The record of hatching is shown in the accompanying table:

Date of Observation.	No. of Eggs.	Length of Period.
7 A. M. July 8	10	11 to 12 days
8 A. M. July 9 (all hatched)	12	12 to 13 days.

From the foregoing records it will be observed that the period of incubation averaged about eleven or twelve days. It will also be noted that while all of the eggs in each lot were deposited within twenty-four hours, hatching occurred over a period of several days.

LIFE HISTORY AND HABITS.

The beetles abandon the pupal chambers in the ground about the middle of May and during early June. In 1914 a few specimens were first observed on foliage on May 26. Examinations of the insects in the ground showed that at this date about fifty per ct. of them were in the larval stage and about twenty-five per ct. in the pupal and adult stages respectively. By May 28 a greater number of the insects had transformed and it was estimated that fifty per ct. or a little more were pupæ and approximately twenty-five per ct. were in the adult stage. Extensive digging, on June 8, of soil beneath willow trees known to harbor large numbers of the insects revealed only three larvæ and no pupæ or adults, while the foliage of the trees literally swarmed with the beetles, their numbers having apparently reached the maximum on June 3. It appears from these facts that during this year the larger percentage of the insects had emerged by the end of the first week in June. During 1915 the larger percentage of the insects were in the pupal stage on April 30, while the remainder were largely larvæ with an occasional adult. On May 6 adults comprised from twelve to sixty per ct. of the insects while the remainder were largely pupæ among which there were a few specimens of larvæ. The first beetles, few in number, were collected feeding on foliage on May 10 and by May 27 they were very abundant on the trees. An examination of the soil beneath the trees showed that, although there were no larvæ or pupæ, a few beetles had not yet made their escape from the ground. The month of April during this year was unusually warm and spring was earlier than on the average, which probably accounts for the accelerated development of the species as compared with the preceding year.

With their appearance on the foliage the principal activities of the beetles are feeding and egg-laying, and at all hours during the day for the month of June especially large numbers of the insects may be observed in copulation. Deposition of eggs begins soon after

the insects appear on the foliage, and in 1914 eggs were first observed on May 30. Oviposition is most active during the month of June, although copulating beetles and eggs may be observed throughout July. Towards the end of July the numbers of the beetles become greatly reduced, and only a few straggling specimens may be observed where hundreds of the insects existed earlier in the season. As previously noted, hatching of the eggs occurs in a little less than two weeks after their deposition. The larvæ on making their escape from the eggs seek the ground, and by burrowing into it disappear from sight. They feed on the roots of various plants and pass the winter in tiny cells or chambers in the earth. Transformation to pupal stage occurs in early spring. Pupation commences about the last of April in low, moist situations and occurs at least a week earlier on high, dry soil. The pupal cell is formed at varying depths, usually from two to three inches below the surface of the ground. It is much longer than wide and approximately twice the length of the pupa when straightened out. Measurements of one cell were 6 mm. long and 2 mm. wide, and of the inmate 3.5 mm. long and 1.5 mm. wide. The cast larval skin is packed into the lower end of the cell. When the cell is broken the pupa will usually be found continually revolving on its long axis and pushing its back against the walls of the cell. Transformation to adults begins about the middle and latter part of May, and the beetles appear during the last week of this month or during early June.

LARVAL ACTIVITIES.

The larva possesses subterranean habits since its life is practically all spent in the soil. Soon after hatching it disappears from the spot beneath the overhanging pellicle of bark where the egg was deposited. Apparently the caudal end of the alimentary duct serves as a sucker, for the creature is able to propel itself on smooth bark for some time, clinging principally by the posterior end of the body. Eventually it lets loose its hold on the tree and drops to the ground. Here it does not seem to burrow directly into the earth, but crawls about until a crack or crevice is found when the insect disappears.

Subsistence appears to be obtained from the roots of plants and perhaps from humus in the soil. At various times, while examining the earth about poplars and willows, larval cells have been observed into which were projecting the tip of a rootlet as if the grub had selected a single root and had followed it up according to the progress of its feeding. In nursery plantations of willow, poplar and birch, which had been carefully cultivated and were therefore largely if not entirely free from all undergrowth, as grass and weeds, it has seemed very evident that the creatures obtained sustenance from the roots of these trees, since there was no other vegetation on which they could feed. With neglected osier willow, growing alongside ditches

and streams, large numbers of larvæ have been observed in the ground immediately adjacent to the trunks of the trees where grasses and weeds scarcely grow, while at more remote distances where there was more or less undergrowth the insects were comparatively fewer in number. This would indicate that the insects under these circumstances obtained food from willow roots.

About Geneva the larvæ are very abundant in the soil about nursery trees and certain shade trees, and to determine the preferences of the beetle for its different hosts, as shown by the numbers of larvæ about them, collections were made of the insects during May, 1915, when they were largely in the larval and pupal stages. Except as noted, the different lots of insects were obtained from three spadefulls of earth taken about young nursery trees:

TABLE I.—NUMBER OF LEAF-BEETLE LARVAE ABOUT DIFFERENT PLANTS.

Host plant.	Number of insects.			
	Larvæ.	Pupæ.	Adults.	Total.
Carolina poplar	3	24	0	27
Lombardy poplar	4	8	0	12
Silver leaf poplar	4	8	0	12
Willow	3	10	0	13
Willow	2	15	1	18
Willow (2 trees)	8	43	1	52
Willow (2 trees)	8	8	0	16
Willow (2 trees)	4	7	1	12
White birch	6	14	0	20
White birch	7	18	0	25
American mountain ash	0	17	0	17
American mountain ash	0	0	0	0
European mountain ash	0	1	0	0
Elm	0	0	0	0
Horse chestnut	0	0	0	0
Sugar maple	0	0	0	0
Linden	0	0	0	0
Apple (2 trees 5 years old)	3	46	16	65
Apple (old bearing tree)	1	0	0	1
Peach	9	20	6	35
Pear	6	43	2	51
Pear	8	43	1	52
Pear (old tree)	0	0	0	0
Plum	9	50	3	62

In various siftings that were made of earth beneath various species of willows it appeared that the insects were considerably more abundant about the weeping willow (*Salix babylonica*), the Wisconsin willow (*S. dolorosa*) and the white willow (*S. alba*) than about the Kilmarnock willow (*S. pendula*), the laurel-leaf willow (*S. pentandra*) and the pussy willow (*S. discolor*), or about poplars

and birches, although they seemed to be more numerous about birches than poplars. Mention has previously been made of the marked preference of the beetles, as judged by their numbers on the foliage, for willows, birches and poplars, which is borne out by the relatively greater abundance of the larvæ about these trees. It will be noted from the foregoing table that many larvæ and pupæ were found about young fruit trees of such sorts as apple, peach, pear and plum. These, it should be clearly understood, were growing in the vicinity of a large row of osier willow which was infested with great numbers of beetles. That the adults feed on the foliage of apples and pears has been conclusively shown, and the occurrence of goodly numbers of larvæ about these young trees indicates plainly that the beetles oviposited freely upon them. So far no evidence has been brought to our attention that the insect breeds in commercial orchards of the different fruits, and rarely does one find any of the beetles in old plantings.

ECONOMIC IMPORTANCE.

As is characteristic of a number of associated species of leaf-weevils in *Polydrusus* and *Phyllobius* and other genera in Europe, the damage occasioned by *impressifrons* is twofold: First, it nibbles the developing buds of budded and grafted stock and then it feeds on the foliage and succulent shoots of a considerable number of plants. The beetles, while small in size, are vigorous eaters, especially during the first week or so following their emergence from the ground, and they continue their feeding over a period of six weeks or more. A number of them, when confined to a relatively small feeding area, as a tender unfolding leaf of an opening bud, may do considerable damage. The history of these insects as a group shows that important injuries of this character are generally intermittent and extreme losses are of rare occurrence. During the ten years that the species has been subjected to more or less close observations by us, conspicuous damages to buds have been detected in only one instance and these occurred during 1912 in a large block of willows in a nursery plantation. The trees were nearly all of a variety known to the trade as the goat willow (*Salix caprea*), grafted to such sorts as New American, Rosemary and Kilmarnock. The latter variety suffered severely as there were literally thousands of the beetles on the small trees, and not infrequently a number of them were attacking the green tips of a single expanding bud or the clusters of small unfolding leaves. Many buds were killed, and those not entirely destroyed produced imperfect leaf clusters. These initial injuries were later aggravated by feeding of the beetles on the margins of the fully expanded leaves. So numerous and destructive has the insect become in certain nurseries that the owners have found it necessary to resort to spraying during some seasons in order to protect their willow plantings. Besides being destructive the insects are

during some seasons so abundant as to be the cause of considerable discomfiture by flying in the eyes or faces of the laborers working among the trees. In its attacks on buds the beetle is apparently most important to budded or grafted stock, which is more susceptible to injury because the opening of the buds and formation of clusters of tender unfolding leaves occur when the pest has emerged in maximum numbers. Unbudded or ungrafted stock or trees would naturally escape attacks of this character since the growth period begins considerably in advance of the time when the beetles normally appear. This difference in susceptibility to injury by *impressifrons* as shown by worked and unworked stock has been noted for other species of leaf-weevils by both Ormerod[27] and Theobald[28] of England, who state that grafted plants in nurseries are especially liable to attack. The latter writer in his account of *Phyllobius maculicornis* and *P. oblongus* states that considerable damage was done by these species in this way in several parts of Kent during 1908. With various species of leaf-weevils this form of attack is of common occurrence.

In its attacks on the fully expanded foliage *impressifrons* feeds largely on the margins of the leaves. The character of this form of feeding is shown in Plates LI and LII, which illustrates the characteristic work of this insect. As will be noted the beetles may nibble along the entire margin of the leaf, from the point of the attachment of the stem to the apex. The injury in this regard is variable. In some instances it consists of a slight gnawing away of the entire margin, at least along one side, in which, however, the general contour of the leaf is maintained, while in cases of extreme damage the beetles may eat large areas of the leaves, which become quite irregular in outline, and occasionally little is left of the original surfaces. With certain kinds of willows feeding by the insects is quite severe as most of the leaves may be more or less eaten, causing the branches to present a ragged appearance. Then again the habit of the insect in attacking succulent stems and shoots often results in the girdling and destruction of the stems, leaves and stalks of the terminal growth. This type of injury is especially common on willow. From our observations so far the attacks by this insect have only been important with certain willows in nurseries, principally budded and grafted stocks, and while more or less evidences of feeding may usually be detected on birches, poplars, apples and pears in nursery plantations, there has been no indication of marked damage with the latter plants. A surprising feature of the insects' activities is that while trees of all the foregoing sorts may be said to be literally alive with the beetles the extent of injury is in the main comparatively unimportant. With a larger species of beetle, such

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[27] Ormerod, E. A. Handbook of Insects Injurious to Orchard and Bush Fruits, p. 141-145. 1898.

[28] Theobald, F. V. Insect Pests of Fruit, p. 119-120. 1909.

as a June beetle, in such great numbers the trees could hardly escape complete defoliation. Outside of nurseries the work of the pest has attracted no attention.

NATURAL ENEMIES.

A common parasite of *Polydrusus impressifrons* is a braconid (*Diospilus polydrusi* Gahan) which attacks its eggs and larvæ. During some seasons this species is very numerous and active and should exert an important repressive action; although judging from the numbers of the leaf weevil this influence is not as yet very marked. The adult parasites may be observed soon after they emerge from their cocoons in the ground during early June about the different situations on the trees selected by *impressifrons* for the reception of its eggs. Not infrequently the host and its antagonist may be observed in near proximity to each other and both engaged in egg laying. In this activity the parasites are very quick in their various movements. They hurry about over leaf and wood, testing with their antennæ every crack and opening along their path, and occasionally they stop to unsheath the ovipositor which is then suddenly inserted under loose bark and repeatedly pushed into an egg mass of the host. The development of the parasite has not been followed completely. Apparently the egg is placed in an egg of *impressifrons*, and the resultant larva, already in the body of the host when it emerges from the egg, drops to the ground with it. There is but a single generation each year, the larva hibernating within the body of the host, where it remains until May of the succeeding year. After destroying the host the tiny brown silken cocoon is formed within the earthen cell constructed by the host larva and in this the parasite completes its development. In 1914 the adults commenced to emerge on June 7 from cocoons that had been collected May 26 and kept in breeding cages, while by June 11 they were taken in large numbers from trees on which eggs of *impressifrons* were being deposited.

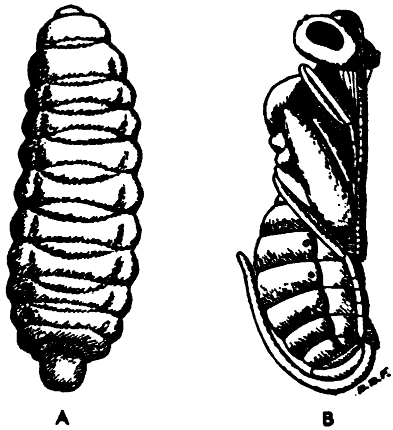

FIG. 19.— PARASITE (*Diospilus polydrusi* GAHAN): A, LARVA; B, PUPA. (Enlarged)

The parasite has kindly been described for us by A. B. Gahan, Bureau of Entomology, U. S. Department of Agriculture, and the description appears in the appendix to this bulletin, p. 422.

METHODS OF CONTROL.

Reference has been made to the practice of certain nurserymen in spraying their plantations when the leaf-weevil is numerous. That the operation rests on a substantial foundation has been established by experiments in both the laboratory and field; for in all cases the beetles have proven to be quite susceptible to arsenical poisons. Goodly numbers of the insects died during the second day after an application of arsenate of lead at common strengths, while the majority of them succumbed within three days after treatment. A small percentage lived in some instances for nearly one week, but they fed only sparingly. From these results it is concluded that should it become necessary to combat the leaf-weevil little or no modification will probably be required in existing spraying practices. While in the pupa stage the insect is especially delicate and usually fails to complete its transformation after the cell has been broken open, even when there has been no mechanical injury to the insect itself. Cultivation, if done with care during midsummer, or, better during early spring, would doubtless prove very destructive to both larvæ and pupæ.

APPENDIX.

DESCRIPTION OF A BRACONID PARASITE OF *Polydrusus impressifrons*.

A. B. GAHAN.

The braconid parasite upon which some interesting biological observations are set forth in the main part of this bulletin appears to be new and in order to supply a name it is herewith described.

Diospilus polydrusi, new species.—" This species is easily separated from the other described forms by its smaller size and the entirely smooth second and following tergites.

Female — Length 3 mm. Head viewed from above, transverse, a little less than twice as broad as long, the posterior orbits about as broad as the eye-width and

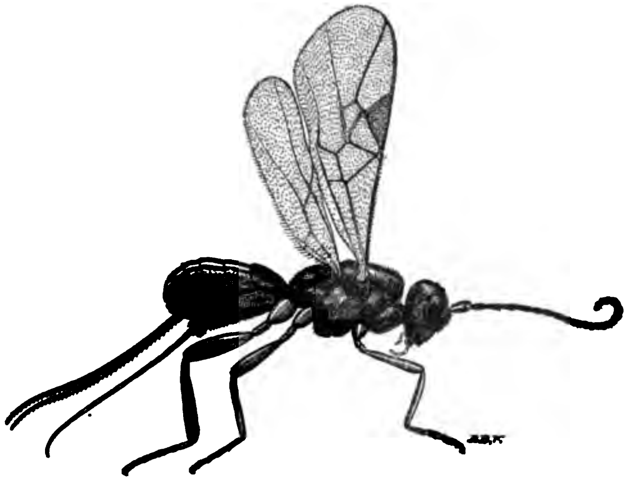

FIG. 20.— PARASITE (*Diospilus polydrusi* GAHAN) ADULT FEMALE. (Enlarged.)

rounded off posteriorly; vertex, frons, and posterior orbits smooth except for a few punctures before and adjacent to the front ocellus; face, immediately below the antennæ, with several transverse rugæ or aciculations which do not extend laterad beyond the outer margins of the antennal fossæ and which become weaker toward the clypeus, finally fading out entirely; the face laterally and below polished; clypeus very broad, more than three times as broad as long, poorly defined laterally, impunctate, its anterior margin broadly convex; malar space less than the width of a mandible at base; antennæ 27-jointed, the first and second flagellar joints subequal and three and one-half times as long as thick, following joints shorter, the apical ten or twelve joints subquadrate or slightly transverse; mesoscutum polished, the parapsidal grooves deep and strongly foveate; scutellum smooth, the suture between it and the mesoscutum divided by only one distinct carina; mesopleuræ mostly polished, the mesepisternauli deep and foveolate; propodeum rugose, with a more or less evident irregular transverse carinate line near the middle and some similarly indefinite lines from this to the apex; first abscissa of radius short, not more than twice as long as thick; second cubital cell somewhat longer on cubitus than on radius; first brachial cell not com-

pletely closed at apex, the part of discoideus behind subdiscoideus effaced; abdomen about equal to the thorax in length, ovate, smooth and polished except the first tergite which is shining but faintly wrinkled and strongly bicarinate on the basal half; ovipositor 2 mm.

Black; basal half of antennæ beneath brownish testaceous, remainder black; clypeus, mandibles except tips, palpi, tegulæ and legs with the exception of the posterior femoræ and tibiæ and all tarsi, pale testaceous; hind femoræ and tibiæ and all tarsi strongly infuscated. Wings hyaline, the venation brownish testaceous, paler at base of wing; abdomen black, the dorsum of segments two and three and venter more or less piceus.

Male.—Unknown.

Type locality.—Geneva, New York.

Type.—Cat. No. 20435 U. S. N. M.

Host.—*Polydrusus impressifrons.*

Described from thirteen specimens received by the writer from the New York Agricultural Experiment Station. The insects were reared June 15, 1916, from the larva of the above named host."

MISCELLANEOUS NOTES ON INJURIOUS INSECTS.*

P. J. PARROTT AND H. E. HODGKISS.

SUMMARY.

The fruit insects discussed in this bulletin are generally of minor importance, though certain of them reveal harmful potentialities, and other species are sufficiently numerous in occasional years to cause considerable damage.

In spite of warnings by this Station, the orchard ermine moths *Yponomeuta malinellus* Zell. and *Y. padellus* L. are being introduced in large numbers into this State by importations of foreign-grown nursery stock. During 1915 the number of localities in which the insects were distributed and extent of nursery stock affected exceeded previous records. The infestations were largely confined to apple seedlings. Observations on mining of leaves and other larval activities on apple are in accord with those of foreign writers upon the species attacking this host.

The leaf-weevil (*Anametis granulata* Say) is recorded as being present in destructive numbers during two different years in plantings of young peach trees in Niagara county. The insects ate opening buds and margins of unfolding leaves. Under confinement eggs were deposited in clusters of three to forty in concealed situations, as folded edges of partially-expanded leaves or in recesses caused by a leaf being folded upon itself.

Unusual numbers of the larvæ of the lesser peach borer (*Synanthedon pictipes* G. and R.) were observed in 1907 and 1908 in one orchard of peach and plum trees at Bellona. Some circumstances of the attack, nature of injuries and habits of the species are briefly noted.

Persisting from year to year unnoticed in the woodlot the lime-tree winter moth or linden cankerworm (*Erannis tiliaria* Harr.) appeared in conspicuous numbers in 1912 in fruit plantings as well as in woodlands. The history of the insect indicates that it occasionally causes injuries in orchards. The peculiarities of the species in a measure limit its ability to be injurious. As caterpillars were not observed in injurious numbers in well-sprayed orchards, it is presumed that the prevailing system of treatment with arsenicals affords the needed protection to fruit trees.

* A reprint of Bulletin No. 423, August, 1916.

The gooseberry fruit-worm (*Zophodia grossulariæ* Packard) occasionally attacks currant plantations in New York, effecting serious losses in fruit yields. The injuries are due to the tunneling of the berries by the larvæ, which draw together fruit clusters and leaves by means of delicate silken threads. Usually several berry clusters are drawn together to form a nest. Spraying with arsenate of lead or paris green as the earliest webs were forming gave a large measure of protection from damages by the larvæ.

In an effort to correlate the different green fruit worms on apple with the moths of the various species, specimens of a common type in one orchard were reared to maturity, which proved to be *Graphiphora alia* Guenée. Descriptions are given of egg and larval instars.

INTRODUCTION.

During the course of their investigations the members of the Department of Entomology often have brought to their attention activities of noxious species of insects other than those that receive primary consideration. This results in the accumulation of notes which, while incomplete and unsuitable for independent publication, possess distinct value and are worthy of permanent record. It becomes desirable from time to time to issue bulletins which contain miscellaneous notes on various injurious insects, and this is the third contribution of the series. The studies reported in this text deal with several species of fruit insects which are discussed in the following order:

1. The orchard ermine moths (*Yponomeuta malinellus* Zell. and *Y. padellus* L.)
2. The peach leaf-weevil (*Anametis granulata* Say)
3. The lesser peach borer (*Synanthedon pictipes* G. and R.)
4. The lime-tree winter moth (*Erannis tiliaria* Harris)
5. The gooseberry fruit-worm (*Zophodia grossulariæ* Packard)
6. A green fruit-worm on apple (*Graphiphora alia* Guenée)

APPLE AND CHERRY ERMINE MOTHS.

(*Yponomeuta malinellus* Zell. and *Y. padellus* L.).

OCCURRENCE.

In Technical Bulletin No. 24 of this Station attention was called to the introduction of the ermine moths (*Yponomeuta malinellus* Zell. and *Y. padellus* L.) into the State of New York through nursery

The number of infested seedlings reported during the past two years approximates 4223 trees, of which 3370 were collected during 1915. The colonies on the different trees showed great variation in the numbers of the caterpillars as shown in the accompanying figures:

TABLE II.— NUMBERS OF CATERPILLARS IN COLONIES OF ERMINE MOTHS

NUMBER OF COLONIES.	Number of caterpillars.	Average number of caterpillars per colony.
169	1,614	9.5
31	258	8.3
47	367	7.6
17	137	8.
594	6,340	10.6
134	1,908	14.2
6	65	10.8
10	156	15.6
10	39	3.9
5	35	7.
16	117	7.3
15	131	8.7
20	68	3.4
73	390	5.3
8	62	7.7
113	406	3.5
214	850	3.9
204	700	3.4
56	200	3.5

As will be observed, the caterpillars ranged approximately from three to sixteen individuals to a colony, all those on a seedling being considered as members of one assemblage, which gives an average of little more than seven of the insects to a colony. In our observations on *malinellus* the smallest number of eggs observed in a cluster on apple seedlings was nine, and the largest number was eighty-three, while the majority of egg masses had between thirty and forty eggs. There is, then, a considerable discrepancy between the average number of eggs in a cluster and the average number of larvæ that has been collected on seedlings, assuming only one egg mass to a plant, which however is not always the case. Various factors are doubtless responsible for the shrinkage, as parasitic and predaceous enemies and handling of nursery stock. In spite of these losses great numbers of the insects have appeared on

TABLE I (*continued*).

DATE OF COLLECTION.	Number of seedlings with nests.	Kind of seedling.	Locality.
June 10, 1915 [3]	8	Apple	Dansville
" 11, 1915 [3]	76	Apple	Dansville
" 11, 1915 [4]	4	Apple	Brighton
" 12, 1915 [3]	9	Apple	Dansville
" 14, 1915 [3]	229	Apple	Dansville
" 14, 1915 [4]	12	Apple	Brighton
" 15, 1915 [4]	12	Apple	Irondequoit
" 15, 1915 [6]	29	Apple	Geneva
" 16, 1915 [4]	2	Apple	Pittsford
" 16, 1915 [3]	92	Apple	Dansville
" 16, 1915 [6]	4	Apple	Geneva
" 17, 1915 [3]	3	Apple	Dansville
" 17, 1915 [4]	25	Apple	Penfield
" 17, 1915 [6]	7	Apple	Geneva
" 18, 1915 [4]	160	Apple	Chili
" 18, 1915 [6]	239	Apple	Seneca Castle
" 18, 1915 [3]	104	Apple	Dansville
" 21, 1915 [3]	171	Apple	Dansville
" 21, 1915 [4]	120	Apple	Mendon
" 22, 1915 [4]	2	Apple	Perinton
" 22, 1915 [3]	45	Apple	Dansville
" 24, 1915 [3]	44	Apple	Dansville
" 24, 1915 [6]	594	Apple	Seneca Castle
" 24, 1915 [4]	5	Apple	Brighton
" 25, 1915 [3]	133	Apple	Dansville
" 25, 1915 [6]	134	Apple	Orleans
" 26, 1915 [3]	26	Apple	Dansville
" 28, 1915 [3]	55	Apple	Grovehurst
" 28, 1915 [6]	283	Apple	Geneva
" 28, 1915 [4]	5	Apple	Brighton
" 29, 1915 [4]	13	Apple	Pittsford
" 29, 1915 [3]	1	Apple	Dansville
July 1, 1915 [4]	21	Apple	Penfield
" 1, 1915 [6]	6	Cherry	Geneva
" 2, 1915 [4]	37	Apple	Chili
" 2, 1915 [6]	169	Apple	Orleans
" 3, 1915 [6]	31	Apple	Geneva
" 6, 1915 [4]	87	Apple	Mendon
" 7, 1915 [7]	47	Apple	Seneca Castle
" 9, 1915 [7]	17	Apple	Orleans
" 9, 1915 [3]	11	Apple	Dansville
" 13, 1915 [3]	1	Apple	Geneseo
" 13, 1915 [4]	13	Apple	Chili
" 14, 1915 [4]	11	Apple	Mendon

* Data kindly furnished by Dr. G. G. Atwood, Chief of Bureau of Horticulture, Department of Agriculture, Albany, N. Y. Collections of insects were reported by horticultural inspectors as follows:
[1] J. A. Maney. [2] B. R. Blanch. [3] L. D. Rhind. [4] J. A. Thomson. [5] Thomas Durkin. [6] B. R. Blanch and W. B. Freer. [7] B. R. Blanch, W. B. Freer and Eugene O'Brien.

shows that the browning results from the loss of the parenchyma, which seems to be all eaten out, beginning from the apex of the leaf, and only the epidermis remains, forming a few inflated cavities or mines. The skin is easily torn and within the mine there will be detected the tiny caterpillars grouped on the borders of the cavity, while the area behind the creatures is full of fine black-brown dust of the excrement. If a leaflet proves insufficient for the nourishment of an entire colony, the caterpillars abandon it and mine a neighboring one. In this way the number of brown leaves toward the time of the blossoming of the apple trees grows ever greater. Later on these leaves wither and fall off. The mining stage of the young caterpillars lasts about two weeks, and the time of their exit coincides in a general way with the full blossoming of the apple tree. With the conclusion of the flowering period the caterpillars enter upon another phase of activity which has been designated the skeletonizing stage. They establish themselves on the upper surfaces of the leaves, being concealed in a light, transparent, greyish web, which may be attached to the lower sides of the leaves above them. The caterpillars feed on the leaves, consuming the pulpy tissues, and leaving only a skeleton of veins. The skeletonizing stage lasts about one week, when the caterpillars pass up in whole colonies to the tips of the highest branches, which they first surround with a web, forming a nest; this they continually enlarge by seizing new leaves and enveloping them with silken threads.

Observations of the young caterpillars at Geneva during 1916 showed that they remained sheltered under the protecting crust of the eggs until the second week in May. On May 19, as bearing apples were almost ready to blossom, small brownish areas in the tips and margins of apple leaves as previously described were detected. At the time of full bloom the mining of the foliage was quite rapid and leaves of fairly good size were not infrequently tunneled for one-half of their area, while small leaves were entirely browned. In ten days more, or as petals were dropping, a few colonies abandoned their positions of concealment within the tissues and fed in exposed positions on the foliage. One colony established itself in the center of a leaf cluster, all the leaves being involved in a web, while another established itself on the upper surface of a leaf and then extended its web to the under surface of a superimposed leaf. At this time the caterpillars were in the "skeletonizing" stage, feeding

on the pulpy substance of the leaves, while the veins were little eaten. By June 1 most, if not all, of the colonies observed had passed the mining stage. Some were observed which had passed the " skeletonizing " period and were on June 6 consuming entire leaves except the principal veins. The capacity for damaging foliage greatly increased from this date with the growth of the caterpillars. The webs, which heretofore had been quite inconspicuous, were now plainly visible, reminding one of the tents that are first spun by the common fall webworm. The destructive activities of the insects ceased by the latter portion of June, at which time they had transformed to pupæ.

SUSCEPTIBILITY TO ARSENICALS.

During the period when they are mining the leaves of apple the caterpillars are apparently not easily destroyed by spraying mixtures. However, upon completion of the tunneling and as they are engaged in feeding openly on the foliage the insects appear to succumb quite readily to applications of arsenicals as provided in the common spraying schedule for the treatment of apple orchards following the dropping of the blossoms. Observations on sprayed seedlings showed that the caterpillars fed sparingly on the leaves and then retreated to the webs, refraining from further eating. In such situations they perished in great numbers and usually there was a total destruction of the insects. In one week from the time of treatment all the affected caterpillars had greatly shriveled and hung suspended from the silken threads that composed the nest.

PEACH LEAF WEEVIL.

(*Anametis granulata* Say.).

According to Pierce[1] the synonymy of this species of leaf-weevil is as follows:

Anametis granulata Say.

Barynotus granulatus Say. Descriptions of North American Curculionides, New Harmony, Indiana, p. 12, July, 1831; Entomology of North America, Le Conte Edition, p. 273, 1891.

[1] Pierce, W. D., Proc. U. S. Nat. Museum, Vol. 45, pp. 365–426, 1913.

Anametis grisea Horn. The *Rhynchophora* of America, north of Mexico, by J. L. LeConte assisted by G. H. Horn, *Proc. Am. Phil. Soc.* 15: 43, 1876.

Anametis subfusca Fall. The Coleoptera of New Mexico by H. C. Fall and T. D. A. Cockerell, *Trans. Am. Ent. Soc.* 33: 212, 1907. Description by Fall on page 261.

The confusion in the identity of the insect as exhibited in the foregoing synonymy has been responsible for the discussion of its work under the name of *grisea*. In 1882 Riley[1] briefly referred to the destructive capacity of the beetle, designated as *A. grisea*, which was reported to him as being injurious to apples and pears in Wisconsin. In 1892 Riley[2] and Howard noted damage to young peach trees in Michigan by *grisea*. It is stated that the beetles hide near the surface of the ground during the day time and eat the bark and also the buds in places during the night. In his report of 1893 Fletcher[3] recorded *grisea* as being destructive at Grafton, Ontario, to apple trees by eating the bark off of young twigs. Mention is also made of the occurrence of the beetle at Okanogan Mission, British Columbia. During the following year he[4] again called attention to the injurious work of the beetle, especially on peaches near Queenstown, Ontario. It is stated that the insects appeared on warm sunny days and attacked the leaf buds and bark of young trees when first set out or when a young tree is budded and cut off near the ground, then by eating the bud they destroy the tree. Mechanical protectors are suggested as means of avoiding injuries to the trees. In 1899 Lugger[5] listed *grisea* as injurious to apple on account of its eating holes in the leaves and feeding on tender bark. He stated that the species hides in folds of a leaf during the day and, while not often seen, it will probably be found to be much more common than is suspected.

With the exception of the preceding accounts dealing with the occurrence of the species on fruit trees there is very little definite data as to its natural food plants, habits or life history. Hamilton[6]

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[1] Riley, C. V., *Amer. Nat.* 16:916, 1882.
[2] Riley, C. V., and Howard, L. O., *Insect Life*, 4:401, 1892.
[3] Fletcher, James, Canad. Exp. Farms Reports for 1893, p. 177.
[4] Fletcher, James, 25th Ann. Rept. of Ent. Soc. of Ontario, pp. 80–81, 1894, and Experimental Farms Reports for 1894, pp. 198–199.
[5] Lugger, Otto, Minn. Agr. Exp. Sta. Bul. 66, pp. 267-268, 1899.
[6] Hamilton, John. *Trans. Am. Ent. Soc.* 32:375, 1895.

recorded that the beetle was not rare on *Ambrosia trifida* during July in southwestern Pennsylvania. Dury[1] has stated that small collections of the insect were obtained by beating vegetation, while Blatchley[2] secured specimens from the foliage of buckeye (*Æsculus* sp.) and other trees and shrubs as early as May and as late as the middle of July.

Wickham[3] writes that he has no direct evidence of the natural food plant of the species and says that the specimens in his collections were largely captured during the month of May in brush land of a mixed type, where there is a great variety of short growth, often including wild plum, wild cherry and crab apple.

DISTRIBUTION.

The leaf weevil has a wide range of distribution. Blatchley[4] gives as the northern limits of its occurrence Newfoundland, Quebec, Ontario and Wisconsin, and says that it exists as far west and south as Wyoming and Texas. Fall[5] states that it is more common in the Mississippi Valley than in the State of New York. The species has been noted from Canada (Thompson[6] from Toronto, May 24, 1910, Wickham[7] from Toronto and Albany on apple, and Pierce[8] from Ontario) and the following states: Michigan (Pierce, Dury[9]); Wisconsin (Pierce, and by Snyder[6] from Beaver Dam, April 29); Ohio (Dury); Illinois (Fall, Wolcott from oak at Willow Springs on August 19, 1905, and Blue Island on Aug. 24, 1905, Liljeblad[6] at Fort Sheridan on June 19 and Rock Island on July 2); Pennsylvania (Hamilton[10]); Ohio (Dury); Indiana (Pierce, Dury, and by Blatchley from Warren, Marion and Posen counties); South Dakota (Pierce); Nebraska (Pierce); Iowa (Pierce, Fall, Wickham from Iowa City and Independence during May, Wolcott and Liljeblad from McGregor during July, 1904); Wyoming (Pierce); Texas (Pierce); New Mexico (Pierce, Dury, Fall and Cockerell); Kansas (Dury); Missouri (Dury, Liljeblad from St. Louis on August 1);

[1] Dury, Chas. Letter dated May 20, 1916.
[2] Blatchley, W. S. Letter dated May 24, 1916.
[3] Wickham, H. F. Letter dated June 2, 1916.
[4] Blatchley, W. S. Letter dated May 24, 1916.
[5] Fall, H. C. Letter dated May 24, 1916.
[6] Wolcott, A. B. Letter dated May 29, 1916.
[7] Wickham, H. F. Letters dated November 8, 1915, and June 2, 1916.
[8] Pierce, W. D. Proc. U. S. Nat. Mus. 45: 382, 1913.
[9] Dury, Charles. Letter dated May 20, 1916.
[10] Hamilton, John. *Trans. Am. Ent. Soc.* 22: 344, 1895.

Colorado (Dury); New Jersey (Smith,[1] Davis[2]); and New York (Blatchley from Portage, Davis from Staten Island).

SOME HABITS OF THE LEAF WEEVIL.

On several occasions our attention has been called to the injurious work of this species in young peach plantings. The first intimation to us of the occurrence of the beetle in injurious numbers in fruit plantings in this State was given by Mr. C. H. McClew, Newfane, who on May 10, 1902, wrote as follows: "I am sending to you a box containing some snout beetles and specimens of injured peach leaves. They are abundant and we can supply you with goodly numbers of them. The insects were first discovered feeding on yearling trees. They attack the plants at night, and during the day partially bury themselves in the ground. The beetle has been reported by others on apple trees and seems more numerous on sandy, loamy soils." No further complaints were made of the insect until the summer of 1912, when Mr. McClew wrote "that the beetle was numerous on young peach trees, which had just been transplanted, and was doing considerable damage by feeding on the opening buds and tender leaves, thus checking the new growth." It is of interest to note also that on account of the attacks by the insects, it was necessary for him to cover the trees with netting until the new growth was sufficient to withstand the insects.

Injuries by the beetle have been first detected by fruit growers during the latter part of May or during early June. As with many otiorhynchid beetles the damage caused by this insect is two-fold: first, it eats into the opening buds, destroying or severely injuring the leaf clusters, and then there is the more common type of injury which is caused by the creatures nibbling along the margins of the leaves (Plate LVI). Observations of the beetles in breeding cages in the laboratory showed that they would chew on the green ends of the opening buds, but rarely did so when tender leaves were available. Injuries to foliage varied with the numbers of the insects. When they were few the damage consisted of little more than the consumption of small semi-circular areas along the margin of the leaf. If foliage was limited in amount, the insects would eat as much as one-third of the area of the leaf or the entire leaf, the main rib only

[1] Smith, J. B. The Insects of New Jersey, p. 378, 1909.
[2] Davis, Wm. T. Letter dated May 22, 1916.

remaining. Feeding by the beetles was observed as late in the summer as August 3 when the last specimen in confinement died. They feed, apparently, at night. If foliage was not heavy they were detected in the day time concealed under small lumps of earth or partly buried in the soil (Plate LV), but if the foliage was abundant they were often observed in the folds of the leaves. The insects avoided the strong sunlight and they showed a tendency to be more active, or at least to occupy more exposed positions, on cloudy days. In the laboratory eggs were deposited from July 2 to July 17. The eggs were laid on the foliage in concealed situations, as the folded edges of partially-expanded leaves or in pockets caused by a leaf being folded upon itself (Plate LV). They occurred in clusters of three to forty eggs to a unit. Masses of twenty to thirty eggs each were very common. The eggs were deposited in irregular clusters embedded in a gelatinous substance, and they were bluntly rounded, and measured about 940 to 987 microns long by 376 microns in width (Figs. 1, 2, 5, Plate LV). In one week from time of laying, the eggs turned brown in color. A cluster of eggs deposited on July 2 hatched on July 15. Larvæ were observed hatching as late as July 19. After hatching the larvæ fell to the ground and were observed soon afterwards in tiny cells just beneath the surface. Owing to the death of larvæ in breeding cages it has not been possible to follow the later stages in the development of the creatures.

METHODS OF CONTROL

As previously stated, this insect has so far caused important injuries only to nursery trees soon after the time of transplanting in the orchard, and growers who have sustained damage by the insect have protected their young trees by covering them with mosquito netting. Since the beetles feed on the foliage it would appear that they can be controlled by a timely application of arsenate of lead. If efficacious, such treatment would be more economical than the use of netting. In the case of peaches, arsenate of lead sometimes causes injuries to the foliage, so great care should be exercised in the use of this arsenical. For experimental treatments it is suggested that the grower apply two pounds of the poison to fifty gallons of water, to which are added two pounds of lump lime previously reduced to a paste. For a small planting considerable protection could doubtless be obtained by collecting the beetles or jarring them into a sheet, when they should be destroyed.

LESSER PEACH BORER.*

(*Synanthedon pictipes* G. and R.)

On May 8, 1907, our attention was directed to destructive numbers of this species at Bellona, N. Y., in an orchard of 1200 trees, consisting of Wickson plums and various sorts of peaches. The trees were six years old and evidently had received very little care. The orchard had not been cultivated for several years and in certain areas there were many weeds besides grass. Pruning had been attempted just before our visit, and the dead trees cut down, which, with the prunings, had been left in the planting. Most of the trees that were seriously infested the year before had succumbed. Nearly seventy-five per ct. of the plums were dead, while the remainder contained many dead branches (Plate IV). The trees seemed to be most injured about or just below the crotch formed by the union of the main branches, and in nearly every case the trees also showed injury about the collar. Some of them were practically dead at this point while the entire top was still alive. The wood beneath the bark showed conspicuous evidences of the work of the borer. Besides the work of the borer the plum trees had the appearance of having been injured also by cold weather or perhaps by unfavorable conditions of environment, though an examination of a number of the dead trees showed that the bark had been entirely girdled by the channels of many insects. What foliage there was looked, on the whole, fairly healthy.

On June 15 the orchards in the vicinity of Bellona were again inspected and the plums were so nearly dead that only a few borers were found; but the peaches, though they had suffered to a much less degree, were generally infested. Somewhat similar conditions existed in another planting of peaches, consisting of trees about four years of age, which had been given cultivation the previous year. In many of the trees every branch showed the presence of one or more borers, and in some cases the trunks were affected. The trees which were infested about the trunk or crotch had evidently suffered injuries to the bark by some other cause previous to the attacks by the borers. In collecting, most of the larvæ were secured from branches ranging from one to two and one-half inches in diameter. The borers apparently did not attack smooth portions of the

* By W. J. Schoene.

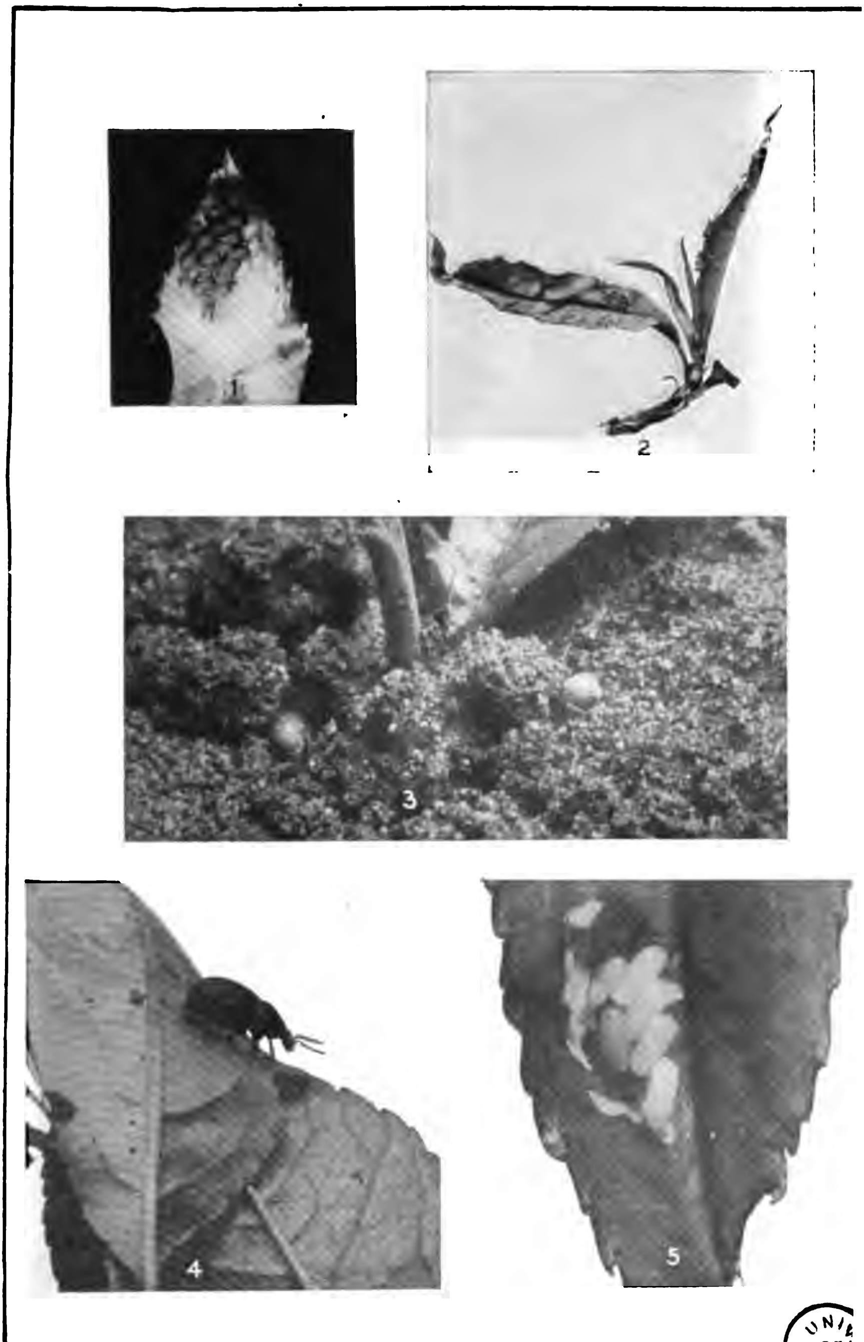

Plate LV.— Peach Leaf-weevil.

1 and 5, Egg clusters (enlarged); 2, eggs in fold of peach leaf and leaf unfolded showing eg cluster; 3 and 4, adult.

PLATE LVI.— PEACH LEAF-WEEVIL: INJURED PEACH FOLIAGE.

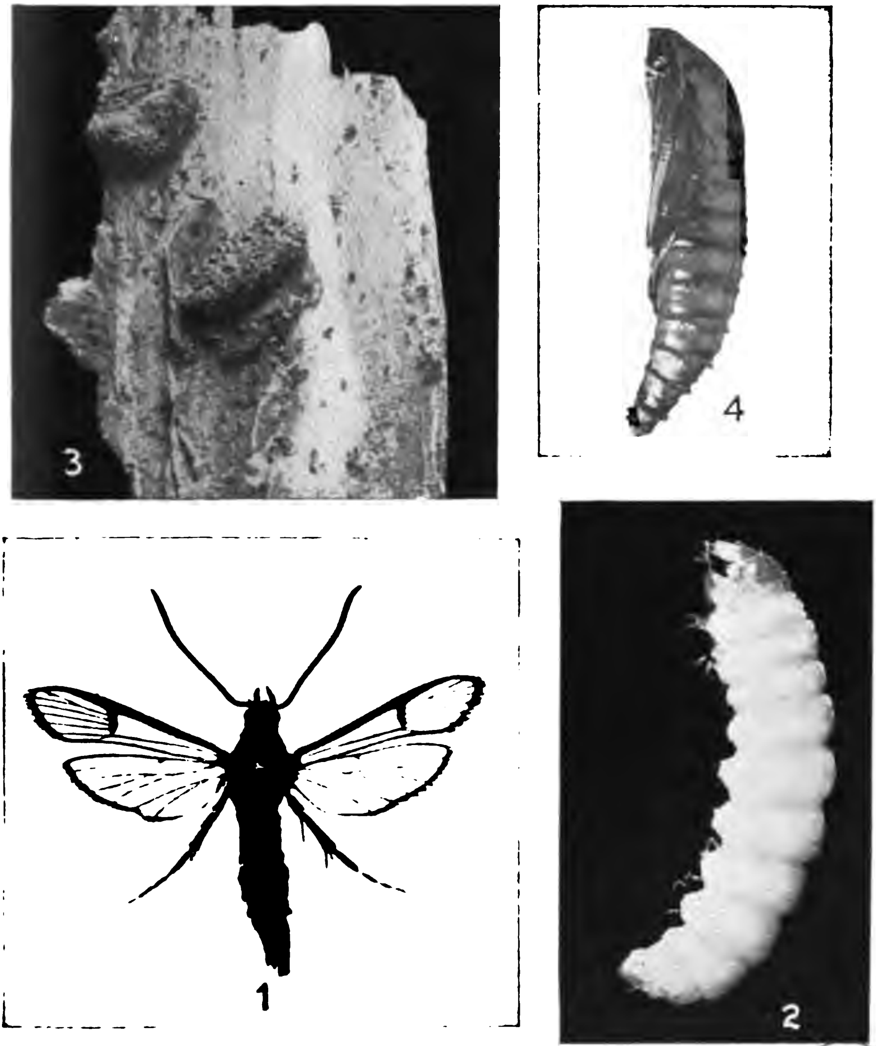

Plate LVII.— Lesser Peach Borer.
1, Adult; 2 and 3, larva and cocoon: 4, pupa.

PLATE LVIII.— INJURIES FROM WORK OF LESSER PEACH BORER.

PLATE LIX.— LIME-TREE WINTER-MOTH.
1, Female adult; 2, male adult; 3. eggs; 4, caterpillar; 5, pupæ

PLATE LX.— LINDEN FOLIAGE INJURED BY CATERPILLAR OF WINTER-MOTH

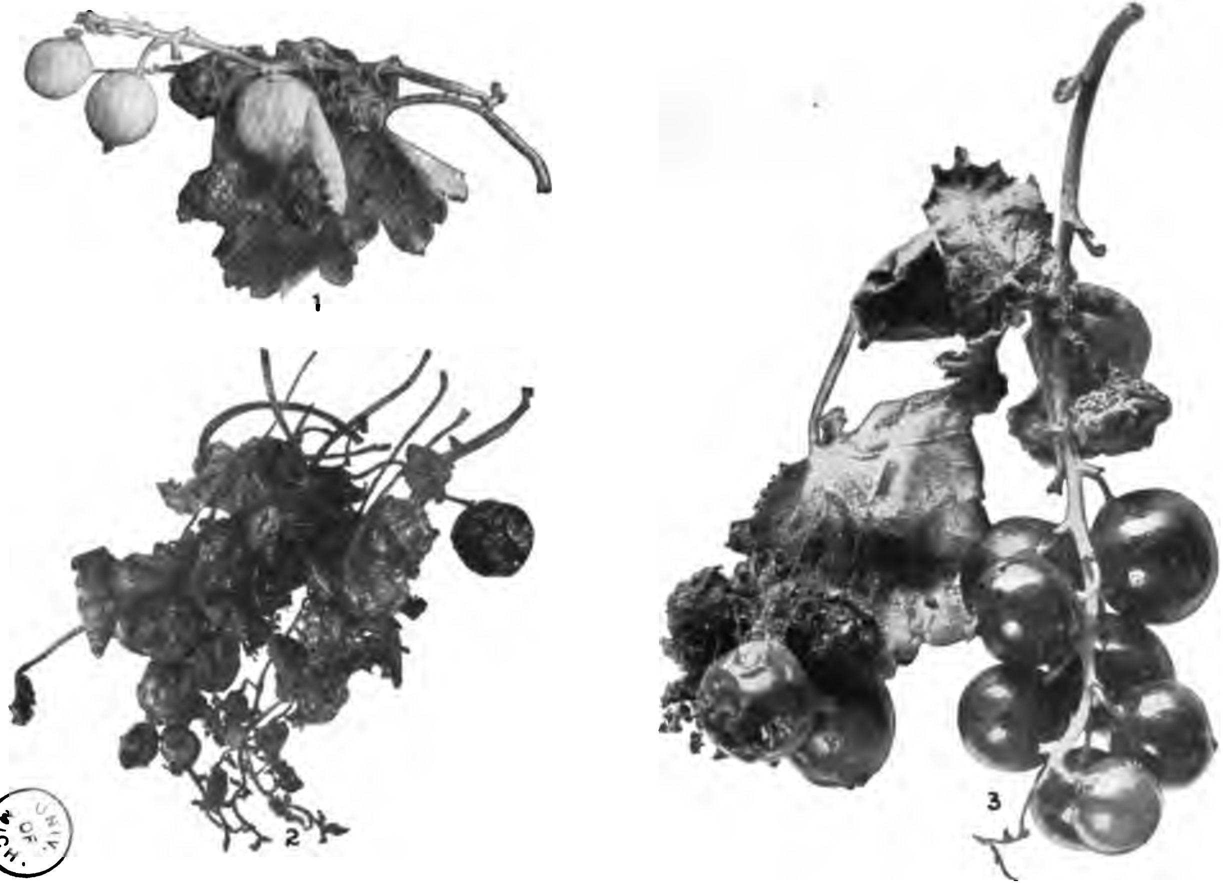

PLATE LXI.—INJURIES TO CURRANTS BY GOOSEBERRY FRUIT-WORM.

Plate LXII.— Green Fruit-worm on Apple.

bark, for all the areas of infestation were located either in a crotch or where a branch had been pruned or broken.

It appears that the Wickson plum is either very susceptible to injury by this insect or that the region about Geneva is unfavorable to the best development of this variety of fruit tree. During the summer of 1907–8 several examinations were made of this and other varieties of plums growing on the Station grounds. It was usual to find a number of larvæ of both *pictipes* and *exitiosa* in the Wickson plum trees, while the insects were relatively scarce in other varieties.

DESCRIPTION OF INJURY.

The larvæ were observed feeding in the soft tissues of the bark in all parts of the trunk and branches, and even twigs one-third of an inch in diameter were infested. The appearances of the wounds varied somewhat according to their location in different parts of the tree. In the smaller twigs the larval channel was concealed by the thin outer cortex, its presence being indicated only by the larval frass and exudation of gum. In the larger branches the bark was often thickened and much discolored. The outer cortex of these enlarged areas was frequently split, which, together with the frass and gum, presented a very rough appearance (Plate LVIII). In the crotch and the main stem several larvæ were frequently found closely associated. Here the surface of the bark was dotted with exit holes made by the pupæ and with an occasional empty pupal case protruding half its length from the bark. In other places the bark was cracked, with the edges turned outward, disclosing underneath, the split surface of the wood covered with finely chewed pieces of bark produced by the caterpillars tunneling their path beneath the cortex. The point of injury frequently covered a number of square inches, the cambium being so thoroughly tunneled that large areas of the bark were dislodged. The lower opening to the wounded area was usually hidden by a large patch of gum, hard on the outside, and protruding near the gum was a mass of excremental particles and larval sawdust, brick red in color, held together to some extent by strands of silk. With the removal of the gum a large hole was found in the cambium, which was apparently the exterior entrance of numerous channels. The pupal cells were detected in the drier parts of these cavities. They were constructed of fine sawdust cemented together with silk and gum and slightly

imbedded in the surface of the sap wood. At other parts of the wound there occurred a fluid, gummy exudation in which were observed caterpillars in various stages of development. The channels of the larvæ were very irregular in shape and ran in varying directions. The dimensions varied with the size of the insect, but the channel was broad enough to permit the larva to reverse itself. A great many channels examined had a longitudinal direction, frequently being four to five inches in length, with two or three side branches an inch or so apart.

ECONOMIC IMPORTANCE AND DISTRIBUTION.

The insect was first described in 1868 by Grote and Robinson[1] who also noted its occurrence in Pennsylvania. In 1879 it was found in injurious numbers upon a plum tree by Bailey,[2] who gave an excellent description of the insect and the character of its work. Two years later Kellicott[3] reported the insect attacking an old plum tree and wild cherries at Buffalo, N.Y., and the same observer stated in 1891 that it fed upon both black and red wild cherries at Columbus, Ohio. Webster[4] recorded peach and the black-knot fungus on cherry and plum as a host of the species, and Beutenmüller[5] added chestnut and juneberry to the list of host plants. The lesser peach borer has been reported as occurring in parts of Canada adjacent to New York, also in Minnesota, Pennsylvania and New Jersey; and Girault[6] in an excellent account of the insect states that it occurs in a number of southern states and adds: "In some of the Georgia and Maryland peach orchards groups of old, scarred trees have been found with their trunks literally honey-combed by the channels of these larvæ." The same author reports that it seems to be on the increase, though according to all reports the insect has been observed in only a few numbers except on old or neglected trees.

LIFE HISTORY, HABITS AND DESCRIPTIONS OF LIFE STAGES.

At the time our observations on the insect began, May 8, 1907, only the larvæ were present on the trees. These varied in length,

[1] Grote, A. R. and Robinson, C. T. *Trans. Amer. Ent. Soc.*, 21:82–183, 1868.
[2] Bailey, J. S. *No. Amer. Ent.*, 1:17-21, 1879.
[3] Kellicott, D. S. *Can. Ent.* 13:7, 1881, and *Ohio Hort. Soc. Journ.*, 5:16–19, 1891.
[4] Webster, F. M. *Ent. News.* 4:267, 1893.
[5] Beutenmüller, W. *Bul. Amer. Mus. Nat. Hist.* 9:220, 1897.
[6] Girault, A. A. U. S. D. A. Bureau of Ent. Bul. 68, Pt. IV, 1907.

being mostly about one-third of an inch. On May 25 two pupæ were found and the larvæ showed greater differences in size, though most of them were from one-half to three-fourths of an inch in length. Thirty days later, or on June 25, the trees were again examined and it was found that a good proportion of the adults had emerged, though one pupa and thirty-five large larvæ were secured. By July 24 practically all of the adults had emerged and only one large larva and one pupa were found. The orchard was again inspected on November 4, when only hibernating larvæ were present. These ranged in size from one-fourth to an inch in length, though some of the largest individuals proved to be of the species *exitiosa*. A final observation was made of the orchard on June 20, 1908, at which time about thirty per ct. of the adults had emerged, thirty per ct. were in the pupa stage and the larvæ were nearly all full size.

These observations indicate that in this part of New York State the adults emerge in June and July, that the insect hibernates as a half-grown larva and that there is but one brood a year. This is in full agreement with Bailey's observation made in the region of Buffalo, N. Y., although Girault reports a partial second brood in Georgia.

Egg.— According to Girault the eggs are small, compressed, elliptical-oval, reddish-brown objects similar in general to the eggs of the common peach borer. They are deposited singly in clusters on all parts of the tree, especially on the trunk, being placed in crevices and openings of the bark and under loosened bark. The female deposits from two hundred to three hundred eggs. These hatch in about ten days.

Larva.— The larva is a typical borer, being white or of a cream color with head yellowish brown and thoracic shield pale yellow (Fig. 2, Plate LVII). Our specimens averaged three-fourths of an inch in length. It is similar in general appearance to the ordinary peach-borer larva, which is about one inch in length. The larva lives in channels or cavities under the bark. If an individual is placed in a glass receptacle with a flat piece of bark it will in a few hours construct a retreat for itself of sawdust and particles of loose bark held together by silk. Half-grown larvæ have been reared to maturity in this manner. In the field larvæ have been observed to live for a time after the tree had died.

Cocoon.— The cocoon (Fig. 3, Plate LVII) is formed of particles of

sawdust and excrement firmly woven together by silk. It is usually slightly reddish or similar in color to bark upon which it is formed. As has been observed by Bailey and others, it has a habit common with many borers of excavating a slight depression in the wood, over which the pupa cell is built. The cocoon is generally hidden on the under side of the bark in or near the larval chamber, though a few have been found in exposed situations on the outside of the bark of small twigs.

Pupa.— The pupa is light in color when first formed, later changing to reddish brown or black. It is about one-half inch in length (Fig. 4, Plate LVII). When ready to emerge the pupa works itself out of the cocoon to a hole in the bark which has previously been made by the caterpillar, and there, projecting for half its length, it changes to an adult.

Adult.— The adults resemble the male of the common peach borer. They are clear-winged moths, bluish-black in color, with the eyes encircled with yellowish-white scales (Fig. 1, Plate LVII). There is a pale yellow band on each of the second and fourth segments. The moths resemble certain wasps both in appearance and manner of flight.

TREATMENT.

The only certain means of successfully combating this pest is that of digging out the grubs as recommended for the common peach borer. The " worming " should be done during the fall, winter or spring months. If in the operation of removing the borers large wounds are made in the bark, they should be coated with an antiseptic, which will protect the cut surfaces during the healing process and act as a deterrent to the insects. A strong mixture of lime-sulphur or bordeaux to which arsenate of lead has been added may be used for this purpose. As the insect is thought to thrive best in old or weakened trees or those somewhat neglected, such as have passed their period of usefulness should be removed and the remainder of the orchard carefully pruned. All dead and injured wood should be immediately burned. In case of bad infestation by this insect severe pruning should be practiced. This will remove many of the larvæ and increase the vigor of the trees. Thorough cultivation should be practised and care also exercised to keep the bark smooth and clean and the trees in a good state of health.

THE LIME-TREE WINTER MOTH.*

(*Erannis tiliaria* Harr.)

This insect takes rank with the white-marked tussock-moth, the common orchard canker worms, the orchard and forest tent caterpillars and certain other leaf-eating insects that persist from year to year unnoticed in the woodlot. The caterpillars of this species occasionally become numerous and cause serious defoliation both in the woods and adjacent orchards.

RECENT OCCURRENCE IN ONTARIO AND CAYUGA COUNTIES.

The presence of large numbers of the caterpillars during the spring of 1912 attracted the attention of many farmers and fruit growers in certain counties in western New York. They occurred in abundance about Hopewell Center, Ontario County, and eastward to Seneca Castle and Geneva. The apple and cherry trees along the roadside were principally affected, though the larvæ were found in commercial orchards of both fruits. One farmer near Hopewell Center reported that the insects were so numerous in his woods that he could hear the caterpillars chewing the foliage. In Cayuga County near Venice Center there are many apple orchards that are either poorly cared for or neglected. Such plantings suffered more or less defoliation due to this and other leaf feeders. The combined work of the canker worms and the orchard and forest tent caterpillars resulted in the defoliation of one orchard and serious injury to several others in the neighborhood of Kings Ferry. The roadside lindens and elms in this vicinity showed the peculiar ragged appearance to the feeding of the caterpillars of this species (Plate LX). The lindens of a woodlot near the worst-injured orchard were partly defoliated. Of the forest trees the elms and lindens were most susceptible and only a few larvæ were found on the maples, hickories, ashes and oaks. Apparently the insects do not naturally feed upon fruit, but in the laboratory under the stress of hunger they ate the epidermis and some of the pulp of cherries and apples.

LITERATURE OF THE SPECIES.

The species is said to be a native insect and is stated by Holland[1] to range from the Atlantic coast to the Rocky Mountains. The

* By W. J. Schoene.

[1] Holland, W. J. The Moth Book, p. 347, 1903.

first authentic record we have is that of Harris[1] in 1841, and as compared with other canker worms he evidently thought this species was not of much importance, as indicated by the following statement. "Apple, elm and lime trees are sometimes injured a good deal by another kind of span worm." Saunders[2] writes "It is often very destructive to basswood, elm, hickory and apple trees." The insect is also mentioned by Packard[3] as being often found on apple and elm. It is of interest to note that no recent outbreaks have occurred and that there is no record of important injuries in this State preceding this appearance of the insect.

BIOLOGY.

The larva is a characteristic canker worm and has in common with other insects of this group the peculiar habit of feigning death by holding the body rigid or suspending itself by the rear feet. The caterpillars feed by chewing elongated areas in the leaves as shown in Plate LX. When the larvæ are numerous the foliage looks as if it had been riddled by shot.

During 1912 the larvæ were first observed on June 8 in an apple orchard near Geneva. The size of the caterpillars indicated that they were nearly mature. On June 19 the creatures were still numerous, though some had entered the soil. Another inspection was made on June 24 when the larvæ had practically all pupated.

The pupæ were found at various depths extending to three inches. Many were found under leaves and rubbish at the surface or in the first one-half inch of soil. A few were found at a depth of three inches. According to Harris the insect remains in the pupa stage until late in October or November and occasionally until spring.

The adults during 1912 continued to emerge in the field from October 21 to November 4, and females were still ovipositing November 10.*

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[1] Harris. Ins. Inj. to Veg. Flint Ed. p. 472, 1862.

[2] Saunders, William. *Can. Ent.* 14:222, 1882.

[3] Packard, A. S. Insects injurious to forest and shade trees, 5th Rept. of U.S. Ent. Com., p. 475. 1890.

* As stated above the adults were observed to emerge out-of-doors October 21 to November 4, and eggs were still being oviposited on November 10. In our unheated insectary a number emerged during the first ten days of December. These facts, when compared with the minimum temperature records appended, are interesting; for they

Habits.— During the day the males have been found resting on leaves and occasionally on the bark. They become active about 4 P. M. Five specimens were taken about electric lights at 9:30 P. M. on October 27, at which time the temperature was 41° F. The females were taken from the undersides of the branches, hanging suspended by their slender legs. They were very sluggish during the day until after mating, when they were observed to slowly creep over the bark, protruding the extensile ovipositor. The females in a cool room continued to oviposit for a week. They scattered their eggs over the bark, some on exposed situations and others in cracks and under the rough bark. From the abdomen of one female there were taken five hundred and eighty-three eggs.

DESCRIPTION OF LIFE STAGES.

Egg. (Fig. 3, Plate LIX.) — Color dirty cream, slightly cylindrical and bluntly rounded at the ends. The sides and one end are marked with compressed hexagonal reticulations. These are more noticeable on the cap. Length .893 mm., width, .517 mm.

Larva. (Fig. 4, Plate LIX.) — A bright-yellow looper with a rust-colored head and ten crinkled black lines along the back. The variation in the width of these lines is such that some individuals are light on the dorsum and others very dark. The dorsal lines are so faint in some caterpillars that they are barely discernible, which gives the effect of two sub-dorsal stripes. In other specimens the black lines are so broad that altogether they appear as a black ribbon. The length of the mature larvæ is from 1.25 to 1.5 inches.

Pupa. (Fig. 5, Plate LIX.) — The males measured 60–65

suggest that the adults do not emerge until after the appearance of freezing weather and that they are able to survive and oviposit in spite of temperatures below 33° F.

MINIMUM TEMPERATURE RECORDS DURING SEPTEMBER, OCTOBER AND NOVEMBER, 1912.

DATE.	Degrees F.	Date.	Degrees F.
Sept. 30	34	Oct. 29	35
Oct. 2	36	Nov. 2	30
Oct. 8	37	Nov. 3	28
Oct. 16	31	Nov. 4	27
Oct. 27	33	Nov. 8	34

hundredths inch long and 15–18 hundredths inch wide, while the females averaged 47–60 hundredths inch long and 17–20 hundredths inch in diameter.

Adult male. (Fig. 2, Plate LIX.) — "The males [1] have large and delicate wings, and their antennæ have a narrow feathery edging on each side." "The forewings of the male are rusty buff or nankin-yellow, sprinkled with very fine brownish dots and banded with two transverse wavy, brown lines, the band nearest the shoulders being often indistinct; in the space between the bands and near to the thick edge of the wing there is generally a brown dot. The hind wings are much paler than the others and have a small brownish dot in the middle. The color of the body is the same as that of the fore wings; and the legs are ringed with buff and brown. The wings expand one inch and three-quarters."

Adult female. (Fig. 1, Plate LIX.) — Our specimens show considerable variation in the color and markings. They range from very dark, having but a few white or brown scales to individuals that are light brown or ash gray, having only a few splashes of black. Most of the specimens present a mottled appearance with a more or less well defined double row of black spots on the dorsum; and in all of our specimens there are two well-defined spots on the dorsum of the first abdominal segment. In some specimens these two spots are equally well defined on all but the posterior segment, in others they are much reduced or lost in the general sprinkling of black. There is a distinctive area of heavy blotches along the stigmatal line. The ground color is silver gray, or with some specimens a light brown. The typical markings are head and front of eyes black, back of head white; dorsum of thorax brownish-white bearing four pairs of black spots. Those on the metathorax not well defined, the rear pair on the mesothorax are well separated and the others contiguous. The antennæ and legs are slender and of the same general color as the body.

TREATMENT.

The peculiarities of this insect in a measure limit its ability to become injurious. The females do not fly, hence there is no danger of a sudden migration to the orchard from the woodlot such as is possible with other species. In addition the habit of emerging during the winter must certainly in a measure limit the production

[1] Harris. Ins. Inj. to Vegetables. (Flint Edition, 1862) p. 473.

of eggs, for the insects that come forth in October are subject in November, in this latitude, to severe and sudden changes, often accompanied by ice storms. Notwithstanding these facts the insects have been known to cause injuries in fruit plantings.

The occasional outbreaks of such insects as this serve to emphasize the necessity of a regular system of orchard treatment that will nip in the bud, so to speak, the multiplication of this and other species of similar habits. Since the caterpillars of this species have not been found in well-sprayed orchards it is taken for granted that the treatments ordinarily made for the common insects afford the necessary protection.

GOOSEBERRY FRUIT-WORM ON CURRANTS.

(*Zophodia grossulariæ* Packard)

Currant and gooseberry fruits sometimes become withered and drawn together in a delicate silken web, which occasionally produces a considerable reduction of the quantities of marketable berries. These injuries are largely caused by the gooseberry fruit-worm *Zophodia grossulariæ* Packard. During 1904, at White Plains, this insect was abundant in the plantation of Mr. Peter Witzel and associated with it were small numbers of the larvæ of the leaf roller, *Archips parallela* Robinson.[1] The feeding of these associated species practically destroyed the yield of currants each year during the period of 1902–1905. Our attention was called to this outbreak late in the spring of 1904 and after many of the berry clusters were injured. Suggestions were made to the owner with the idea of securing relief from the pest until an investigation could be undertaken. The studies were begun in 1905 but later were discontinued. Some information on methods of control was obtained which, while fragmentary, is mentioned as a guide to further studies on the protection of Ribes from attacks of these pests.

SUMMARY OF LITERATURE.

Although the gooseberry fruit-worm is common and of considerable importance in plantings of Ribes in some regions, there are few published accounts which contain really satisfactory information concerning this species. Most of the citations appear to be largely

[1] Determination through the courtesy of Prof. C H. Fernald.

compiled from the reports of Riley[1] and Saunders[2] who have published the most complete notes on the insect up to the present time. Other writers have been satisfied to quote from these authorities and no later investigations appear to have been made.

APPEARANCE OF INJURIES.

The work of this species on currants has received little attention in literature and much of what has been written is inaccessible to most workers. In 1855, Fitch[3] reported having seen wild gooseberries with every berry withered. Riley in 1869 noted its attacks on native gooseberries and green-gage plums. During 1876 Saunders observed the work of this species and in 1883[4] again published a very concise account of its attacks on Ribes. In such instances the gooseberries ripened prematurely or else became dull whitish in color and soon withered. The currants were drawn together and the berries fastened to each other with silken threads. Lochhead[5] noted the premature dropping of well-formed unripened fruits which at that time showed no external evidence of the cause of injuries. A few days later the heart of the berries softened and the presence of larvæ became evident through the softening of the tissue at the center of the berries and the subsequent collapse and decay of the fruits. An external evidence of injured gooseberries was a dark spot on the skin which gradually increased in size until the pulp became red but not ripe. Thick-skinned berries appeared not to be affected. According to Slingerland and Crosby[6] several fruits may be connected by a delicate silken thread.

In our study this insect was especially destructive to red currants during the period of 1903–1906. The earliest indication of infestation was in May when the berries were drawn together by a delicate silken thread. The young larvæ within the web afterward began to eat into the fruits which soon became shriveled and decayed (Plate LXI). In some instances the berry injury consisted only of a wound in the skin, but in any case the fruits dried and shriveled. Usually several berry clusters and adjacent leaves were drawn

[1] Rpt. State Ent. Mo. 1:140, 1869.
[2] Rpt. Ent. Soc. Ont. (Canada) 7:39–40, (1876), 1877.
[3] Rpt. State Ent. N. Y. 3:437, 1855.
[4] Insects injurious to fruits, pp. 357–359, 1883.
[5] Rpt. Ent. Soc. Ont. (Canada) 34:35–36 (1903), 1904
[6] Manual of Fruit Insects pp. 353–355, 1914.

together to form a nest in which occasional larvæ transformed. Often leaves only were drawn together, and the caterpillars did not feed on the berries. On the other hand single currants only were eaten, or two or three fruits in a cluster affected. In many instances the currants ripened prematurely with no other evidence of the larvæ at work.

DISTRIBUTION AND FOOD PLANTS.

Dyar [1] lists the range of this species in North America as north eastern United States and Canada. In other sections it has been reported as occurring in Missouri, Minnesota, Montana, Illinois, Oregon and Washington where it also feeds chiefly on Ribes. The native and cultivated gooseberries, red and white currants, and green-gage plum, according to an obscure reference by Riley, are the recorded hosts of this species.

LIFE HISTORY AND HABITS.

The adult female deposits her eggs on the young gooseberries a short time after the fruit is set. The young larvæ soon appear and bore into the berry. On April 21 at White Plains, N. Y., no trace of an infestation could be found. During the second week in May occasional berries were being drawn together by a delicate silken thread which that year was the earliest evidence of the insect in this planting. About the last week in May the caterpillars left the berries first attacked and webbed together other fruits of the cluster. As the creatures became larger in size several berry clusters were usually drawn together and formed a nest in which the caterpillars remained concealed. When disturbed the larvæ quickly left the berries or the nest and lowered themselves to the ground with the aid of a slender thread. By June 7 the caterpillars were mature, and on June 28 few of the creatures were to be found. On the latter date many delicate, finely-woven cocoons were found among the injured currant clusters or fallen leaves and other debris on the ground beneath the bushes. Specimens of these cocoons and others obtained from larvæ bred in the laboratory were placed in cages where they remained until the following spring when the moths emerged. The adults appeared during the last week in April.

[1] U. S. Nat'l Mus. Bul. 52, p. 429, 1902.

DESCRIPTION.

The following stages of the insect were noted:

First instar.— Body whitish; head, thoracic shield, and appendages ferruginous. Pro-legs similar to body with a brownish ring at their extremities. Spiracles ringed with brown. Anal segment tinged ferruginous and hairy. Length 5½ mm., width, 1 mm.

Second instar.— Body white, finely pitted with dark points. Thoracic shield, dark ferruginous; Head and mouth parts somewhat lighter, showing reddish translucent. Thorax and abdomen concolorous with hairs regularly placed in rows. Anal segment same color as other abdominal segments. Appendages somewhat tinged with brown. Less dark color in this stage than in preceding instar. Length 8 mm., width 1½ mm.

Third instar.— Body yellowish; head light amber. Mouth parts reddish brown. The thoracic shield similar to head in color. Thorax and abdomen finely punctured, giving blackish cast. Hairs regularly placed in rows. Length 10½ mm., width 2 mm.

Fourth instar.— Body pale green with faint tinge of yellow; head much swollen; yellowish translucent in color; thorax and abdomen as before. Length 13 mm., width 3 mm.

Fifth instar.— Deeper green than preceding instar. Anal segment with a suggestion of yellow. Head yellowish translucent. Abdomen deeper green, translucent, distinctly tinged with red; becoming deeper as stage lengthens. Length 15 mm., width 4 mm.

Pupa.— When fully formed the pupa has first a greenish tinge which gradually changes to a mahogany brown color. The spiracles are papilliform and rather prominent. A whorl of hooks surrounds the anal tip.

Cocoon.— Light, fluffy, silken structure of a close weave; often attached to several leaves or may hang from a bunch of currants.

Adult.— " Expands 22–25 mm. Labial palpi, head, antennæ and thorax fuscous gray; fore wings very light gray overlaid with fuscous and blackish; basal field rather darker in the middle; basal line near base whitish, rounded outwardly, followed by a broad, even, rounded, blackish band; middle field with blackish running somewhat in longitudinal striæ, with two parallel, somewhat coalescing white stripes just anterior to middle; discal spot fuscous, diffuse, dentated; outer line, white dentate rather oblique, distinct, margined within with blackish, more marked costally, and lined outwardly

with blackish, which extends over the outer field; marginal points black. Hind wings light fuscous, pellucid.[1] "

CONTROL MEASURES.

Suggestions for the control of this pest usually made since the work of Riley and Saunders have largely consisted of preventive measures such as hand picking of infested fruits or clusters or of allowing poultry to have the run of the garden.

In 1904 the plantation under observation was divided into four plats which were either sprayed with a weak caustic soda solution, or arsenate of lead, or dusted with hellebore. This work was done by the owner after webs were formed and when the berries were largely destroyed. No appreciable differences were noted between the sprayed and unsprayed bushes at the time pupation commenced.

In the spring of 1905 the planting was divided into four plats which were sprayed respectively with lime-sulphur wash, arsenate of lead and paris green in bordeaux mixture, with one plat as check.

The lime-sulphur spray was applied before the buds opened and was used largely for the San José scale. It did not act as a deterrent to the berry moth. The poison sprays were applied just as the first webs appeared on the currants. No great differences in effectiveness were noted between the two poison sprays. These treatments were very beneficial, and in both instances little damage resulted from the work of the insects on the sprayed plats.

In 1906 the garden was again sprayed with either arsenate of lead or paris green in the usual proportions just as the earliest webs were being formed. On June 1 scarcely any injured berries or clusters were observed, although the unsprayed bushes were quite badly infested.

A GREEN FRUIT-WORM ON APPLE.*

(*Graphiphora alia* Guenée.)

The common species of green fruit-worms, which cause trouble in apple and pear orchards by chewing holes in young fruit, have generally been considered as belonging to the genus *Xylina*. In an effort to correlate the different types of green fruit-worms found on the apple with the moths of the various species, the writer reared

[1] N. A. Lepidoptera, Hulst, Geo. D. Trans. Am. Ent. Soc. 17:173, 1890.
* By B. B. Fulton.

to maturity a number of specimens of a type most numerous in a neglected orchard near Geneva, N. Y. (Plate LXII). These pupated about the end of June, 1913, in earth contained in flower crocks and were buried in the ground for the remainder of the year. On March 27, 1914, five moths appeared, a sixth emerged on March 28, and a seventh on April 2. All proved to be of the species *Graphiphora alia* Guenée. Another specimen which had been reared from a green caterpillar collected on basswood, emerged April 2 and proved to be identical to those reared from caterpillars on apple.

In 1914 another lot of larvæ was collected from the foregoing apple orchard. They were all carefully examined and were divided into two distinct types, one of which was probably a species of *Xylina* although none matured, while the other and the more numerous type proved to be larvæ of *Graphiphora alia* (Fig. 22). The latter pupated during the last week of June and were kept buried in a flower crock over winter. A pair of these moths emerged on April 7, 1915, about 9 A. M. These were put in a breeding cage and eggs were deposited on April 10 or 11, which hatched during the forenoon of April 16.

The young larvæ were placed on opening apple buds in lantern globes. They tunneled into the buds and fed on the young leaves. They grew rapidly in the laboratory and reached full size by May 15. In the later stages many of the larvæ became very dark (Fig. 2), much darker than the larvæ from which the adults were reared, but retained the same structure and markings exhibited by the light specimens.

DESCRIPTION OF LIFE STAGES.

Egg.— The egg (Fig. 21) is of the type common to the group. It is hemispherical, about .65 mm. to .70 mm. in diameter and of a pale purplish gray color. Its surface is ornamented with between thirty and forty ribs which radiate from the center. The ribs are somewhat wavy in outline and are made up of a series of elevations.

FIG. 21—EGG OF *Graphiphora alia* (ENLARGED).

Larva: *First instar.*— Pale, uniform, greenish gray. Head and dorsal plate on first segment black and

shining. Last segment dark. Each segment with several black bristles with black spots at the bases. Length 1.75 to 2.5 mm. Head .37 mm. wide.

Second instar.— Body grayish green, more green on posterior part. With five longitudinal pale lines, consisting of a median dorsal and paired lateral lines, and a narrow pair of lines intermediate in position and indistinct on first three segments. Head dark brown; plate on first segment light brown. Length 3.6 to 6 mm. Head .57 mm. wide.

Third instar.— Body darker green. White lines more distinct. Head light brown; plate on first segment pale. Length 7 to 9 mm. Head .87 mm. wide.

Fourth instar.— Body light to dark green. Head pale, mottled with brown spots. Two pairs of bristle-bearing black spots nearest

FIG. 22.— LARVA OF *Graphiphora alia* (ENLARGED).

median line on each segment are bordered on the outer side by a larger white crescent-shaped spot. Length 10 to 16 mm. Head 1.37 mm. wide.

Fifth instar.— Body light green or in some specimens dark grayish green; color darkest just above lateral white lines. Upper parts and portion of sides below lateral line speckled with minute white spots. Outer faces of prolegs with a black patch. Length 18 to 22 mm. Head 2.2 mm. wide.

Sixth instar. (Fig. 22.) — Color light yellowish green or occasionally dark grayish green, darkest toward the sides; the first and last segments paler. With five longitudinal white or cream-colored lines. The median line is narrow on the first three segments and ends on the penultimate segment. The broad lateral lines include the stigmata and are clouded with gray on the lower half; the posterior end slants downward and runs to the tip of the posterior leg. The intermediate lines are irregular in outline and much broken near the anterior and posterior ends. The whole upper

part of the body is speckled with minute whitish spots. The black bristle-bearing spots are small and inconspicuous; the two pairs nearest the median line on each segment are bounded on the outer side by prominent white spots. Head pale, mottled with light brown. Thoracic legs dark at tip only; prolegs with a dark patch on the outer face. Ventral area pale. Length 30 to 35 mm. Head 3 mm. wide.

FIG. 23.— ADULT OF *Graphiphora alia* (ENLARGED).

Adult. (Fig. 23.) — "Varies in ground color from pale luteous gray to dark grayish brown.[1] Median lines obsolete or very faint; t. p. line usually punctiform. S. t. line irregular, pale, preceded by a darker shade. A row of black terminal dots. Ordinary spots large, pale ringed, reniform usually darker, at least inferiorly. Secondaries pale fuscous, powdery. Beneath powdery, with more or less complete common line and distinct discal spot. Head and thorax concolorous. The harpes (Fig. 24) of the male are suddenly narrowed and curved toward tip, which at its inferior angle is produced into a long, straight, acute process. The clasper is long, slender, regularly curved and acutely terminated. At the base there is an additional small, slender corneous process. Expands 1.40 to 1.60 inches (35 to 40 mm.).

FIG. 24.— GENITAL STRUCTURES OF *Graphiphora alia.*

Habitat.— Northern, Middle and Eastern States; Missouri."

[1] Smith, J. B. Revision of some Taeniocampid Genera, Proc. U. S. Nat. Museum. Vol. 12, p. 487, 1889.

SOME INSECTS ATTACKING THE PEAR, AND THEIR CONTROL.*

P. J. PARROTT.

[This matter was prepared for a publication of the State Department of Agriculture and first used there. It is here reprinted without change in text but with numbers of figures adapted to the series in this report.]

The pear is subject to attack by many of the insects that are injurious to the apple. As is characteristic of all fruits, however, there are certain pests peculiar to it or to which it displays an unusual degree of susceptibility — as the pear psylla, the sinuate borer, or the pear thrips. The more injurious species to be considered in the upkeep of a pear orchard may be classified in the following order:

Insects attacking the trunk and branches.— Sinuate borer, round-headed borer, flat-headed borer.

Insects incrusting the bark.— San José scale, oyster-shell scale, scurfy scale.

Insects attacking the blossom buds and fruit.— Codling moth, false tarnished plant bug, pear midge, pear thrips, plum curculio, bud moth, leaf rollers, green fruit worms.

Insects attacking the foliage.— Pear psylla, pear slug, blister mite.

INSECTS THAT ATTACK THE TRUNK AND BRANCHES.

The Sinuate Borer.

The sinuate borer, *Agrilus sinuatus* Olivier, which is of European origin, appears to be confined to five or six fruit-growing counties contiguous to the Hudson River in the southeastern part of the state. Its ravages have been of such a character that it has almost discouraged the planting of pears, and it now promises to exterminate the orchards that were established before its appearance in that region. The adult insect is a small copper-colored beetle about one-third of an inch long. It makes its appearance during the fore part of June and deposits its eggs in depressions or crevices in the bark of the trunk or branches. Upon hatching, which occurs about the first of July, the young larva burrows directly from the egg to the sapwood, where it cuts an irregular serpentine mine that is very characteristic and easily distinguishable from the work of other borers attacking pear trees. The girdling of the bark kills the trees or weakens them so that they lapse into a languishing state and become unproductive.

* A reprint of Circular No. 51, May 15, 1916.

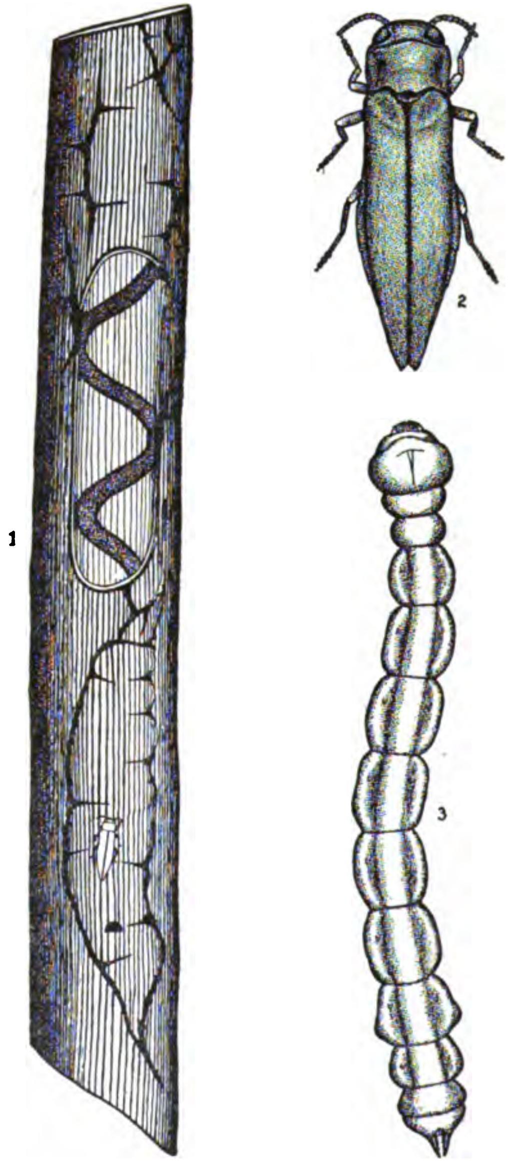


FIG. 25.— THE SINUATE BORER: (1) WORK OF BORER IN BARK; (2) ADULT; (3) LARVA.

Treatment. Wood-boring insects are generally difficult pests to combat, and this beetle in particular presents a series of difficulties not usually encountered in a single species. For small trees perhaps the most satisfactory method of control is to cut into the mine of the insect and destroy the inmate. The course of the mine can usually be traced by the discoloration and splitting of the bark following the tunneling by the borer. Recent studies have shown that the beetles feed readily on the foliage, and they point to the possibility of successfully controlling the insect by an application of an arsenical spray during the latter part of May, or shortly before the beetles begin to appear. Worthy also of trial during early June is an application of a deterrent wash to the trunks and branches in order to prevent oviposition. For bearing orchards the latter measures are recommended tentatively, pending the results of our experiments to determine their merits.

The Round- and Flat-headed Borers.

The round-headed borer, *Saperda candida*, Fab., and the flat-headed borer, *Chrysobothris femorata* Fab., are very destructive pests to different fruit trees, including the pear, and they do more damage than the average grower appreciates. The injuries are caused by the grubs, or larvæ, that work beneath the bark. If the burrows or channels of the insects are numerous, the bark may be girdled, resulting in the decline and death of the trees. Recent investigations have also shown that insects play an important role as disseminators of diseases. It is now believed that various wood-boring insects are in part responsible for cankers and other disorders of the trunks of fruit trees. The wounds and holes in the bark produced by these pests certainly make it possible for disease-producing organisms to establish themselves in the tree.

FIG. 26.—THE ROUND-HEADED APPLE TREE BORER

The adult round-headed borer is a handsome beetle about three-quarters of an inch long and light brown in color, with two white stripes across thorax and along each wing. The adult of the associated species is a dull metallic brown in color and about one-half inch in length. The life histories of the two insects are very similar. The eggs are deposited in crevices or slits in the bark, and from these there develop the pale grubs, which may be observed working beneath the bark and which are familiar to most growers.

Treatment. The trees, especially in young plantings, should be inspected every fall and spring for discolored areas in the bark or for wounds from which there is exudation of sap or for sawdust-like castings. When such are detected, the borers should be cut out by means of a strong, sharp knife. Grubs buried deeply in the heartwood may be destroyed by probing with a piece of wire or by injecting carbon bisulphide into the burrows, after which the openings should be immediately sealed with grafting wax. As unthrifty trees are more susceptible to attack, the needs of the orchard in other respects should be given careful attention for the purpose of stimulating the trees to outgrow the injuries and ward off subsequent attacks.

INSECTS THAT INCRUST THE BARK.

The San José Scale.

San José scale, *Aspidiotus perniciosus* Comstock, ranks as one of the worst pests of fruit trees. Besides the pear, it attacks the cherry, apple, peach, plum, currant — practically all our common orchard trees and bush fruits. It thrives also on many shade trees and ornamental shrubs.

Large numbers of this scale appear as a grayish, scurfy deposit, not unlike a coat of ashes. The bark becomes rough and dull instead of having a smooth and polished appearance. Branches that are infested with large numbers of the insect usually show dead twigs, and foliage is sparse. Infested leaves are often marked with red or purplish spots. The pears are rough, scabby, and spotted with red, the reddish discoloration being most noticeable around the margins of the scales. The wonderful power of reproduction of this species makes it the most formidable of our orchard scales.

Treatment. To combat San José scale, the grower should apply lime-sulphur solution late in fall or preferably in spring just before the leaves begin to show. The concentrated solution, testing from thirty-two to thirty-four degrees Baumé, should be diluted in the proportion of one gallon to eight or nine gallons of water. Commercial miscible oils diluted with twelve or fifteen parts of water are used with considerable success by some growers. These preparations should be applied in spring while buds are swelling.

The Oyster-Shell Scale.

Oyster-shell scale, *Lepidosaphes ulmi*, Linn., appears as a brown scale about one-sixth of an inch long, closely resembling the bark in color and somewhat like a long, narrow oyster shell in shape. In some seasons the insects appear in such numbers that twigs and

branches are literally covered, in which event the health and vigor of the trees are seriously impaired. This species is commonly found on pear and apple, although it attacks many other plants.

The Scurfy Scale.

Scurfy scale, *Chionaspis furfura* Fitch., somewhat resembles the oyster-shell scale, but is easily distinguished from it by its greater

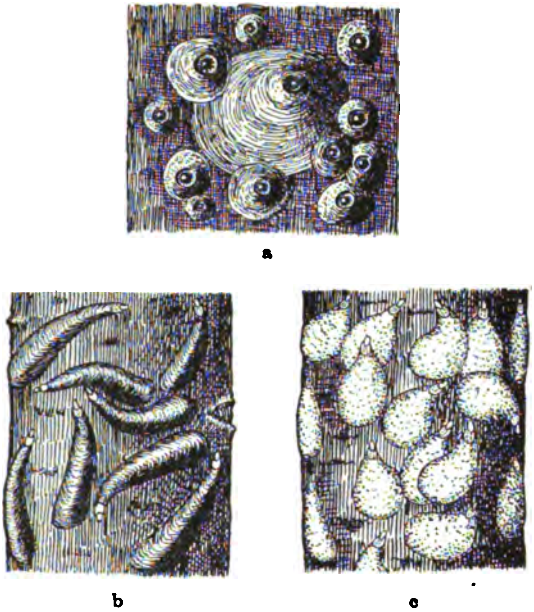


FIG. 27.— COMMON SCALE INSECTS (Much Enlarged).
(a) SAN JOSE SCALE, (b) OYSTER-SHELL SCALE,
(c) SCURFY SCALE.

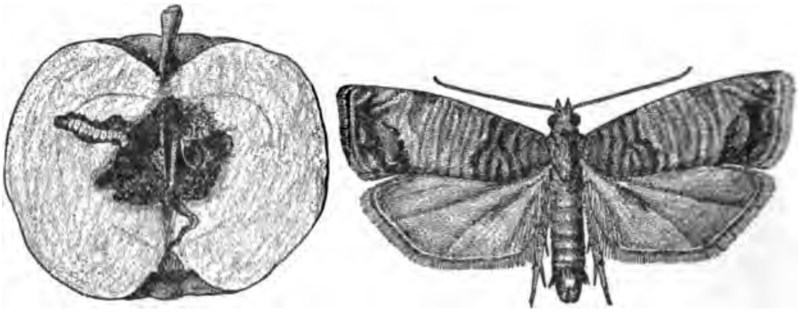
breadth and white color. When present in large numbers it is conspicuous by its contrast with the dark bark. It is common on pear, apple, and quince.

Successive years' spraying with the lime-sulphur mixture as indicated for San José scale will also free the trees from oyster-shell scale and scurfy scale. About the middle of June, as the young scales hatch, the latter species may also be efficiently controlled by applying one pound of fish-oil soap dissolved in five gallons of water, or kerosene emulsion diluted with eight parts of water.

INSECTS THAT ATTACK THE BLOSSOMS AND FRUIT.

The Codling Moth.

The codling moth, *Carpocapsa pomonella* Linn., is responsible for wormy pears. The damage to the fruit is done by a worm, or caterpillar, of a small moth, popularly known as the codling moth. There are two broods of worms. The first brood appears in early summer, while the second brood is active during late summer. The worms of the first brood are hatched from tiny disklike eggs, laid on the trees by the parent moths, on or near young pears. Two or three weeks after the trees have blossomed, the eggs hatch. The young worm crawls to the blossom end of the pear and burrows into the interior of the young fruit, feeding as it goes. After feeding for two or three weeks, the worm leaves the pear and spins a



a b

FIG. 28.— THE CODLING MOTH: (a) WORK IN APPLE; (b) MOTH.

cocoon under the rough bark of the trees or under adjacent rubbish. Within this cocoon it changes to a pupa, and later to a moth, which is the codling moth of the second brood. In the latitude of Geneva the second brood of moths appears during the latter part of July or early August. During some seasons, the late brood of worms is rather numerous and is responsible for the increasing numbers of wormy fruit as the time of picking approaches. These late worms spend the winter in cocoons as described and do not transform to moths until spring, after the trees have blossomed.

Treatment. Nearly all the codling-moth worms seek the blossom, or calyx, end of the young pear, where they feed before burrowing into the interior. The object in spraying is to coat this portion of the young pear with poison so that the worm may be destroyed at its first meal. The best time to apply the poison is after the blossoms have largely dropped and before the calyx cup closes. Direct the nozzles so that the spray will be shot into the throat of every blossom. or calyx cavity.

Arsenate of lead is recommended, as it is extremely poisonous to the codling-moth worms and on drying is very evenly distributed. If it is properly made, it is the most adhesive of spraying poisons and does not generally cause burning of foliage. Bordeaux mixture is recommended as the carrier of this poison. Arsenate of lead should be employed in the proportions of two or three pounds to fifty gallons of water, or of bordeaux mixture, if it is desired to apply a fungicide.

The False Tarnished Plant Bug.

The false tarnished plant bug, *Lygus invitus* Say, is responsible for a diseased condition of pears characterized by the cracking open of the skin in small spots and the formation of protruding granular areas. Fruits seriously injured are usually much deformed and undersized. The damage is done by the nymphs that make their appearance during the period when the trees are coming into blossom and until pollination is completed, when the young fruits are the size of filberts. A single nymph may stab a pear many times, and, while the initial wounds are at first slight and seemingly inconsequential, they nevertheless produce a disfiguration that becomes increasingly prominent as the fruit increases in size. All the leading sorts of pears are subject to injury.

FIG. 29.— THE FALSE TARNISHED PLANT BUG: NYMPH PUNCTURING A YOUNG PEAR.

Treatment. Spray the trees with three-fourths of a pint of nicotine solution (40 per ct.) to one hundred gallons of water, to which is added three pounds of soap to cause the liquid to stick and spread better. The application should be made just after the blossoming period or when petals are falling.

The Pear Midge.

The pear midge, *Contarinia pyrivora* Riley, causes young pears to become stunted and deformed. The identity of the species is readily recognized by cutting into a young affected fruit, when tiny maggots will be observed working in and around the core. Eggs are laid by a tiny midge in the interior of the unopened blossom. On hatching, the young larvæ work their way to the ovary and feed about the core. After completing its growth, the maggot abandons the fruit and enters the ground, where it remains until the following spring.

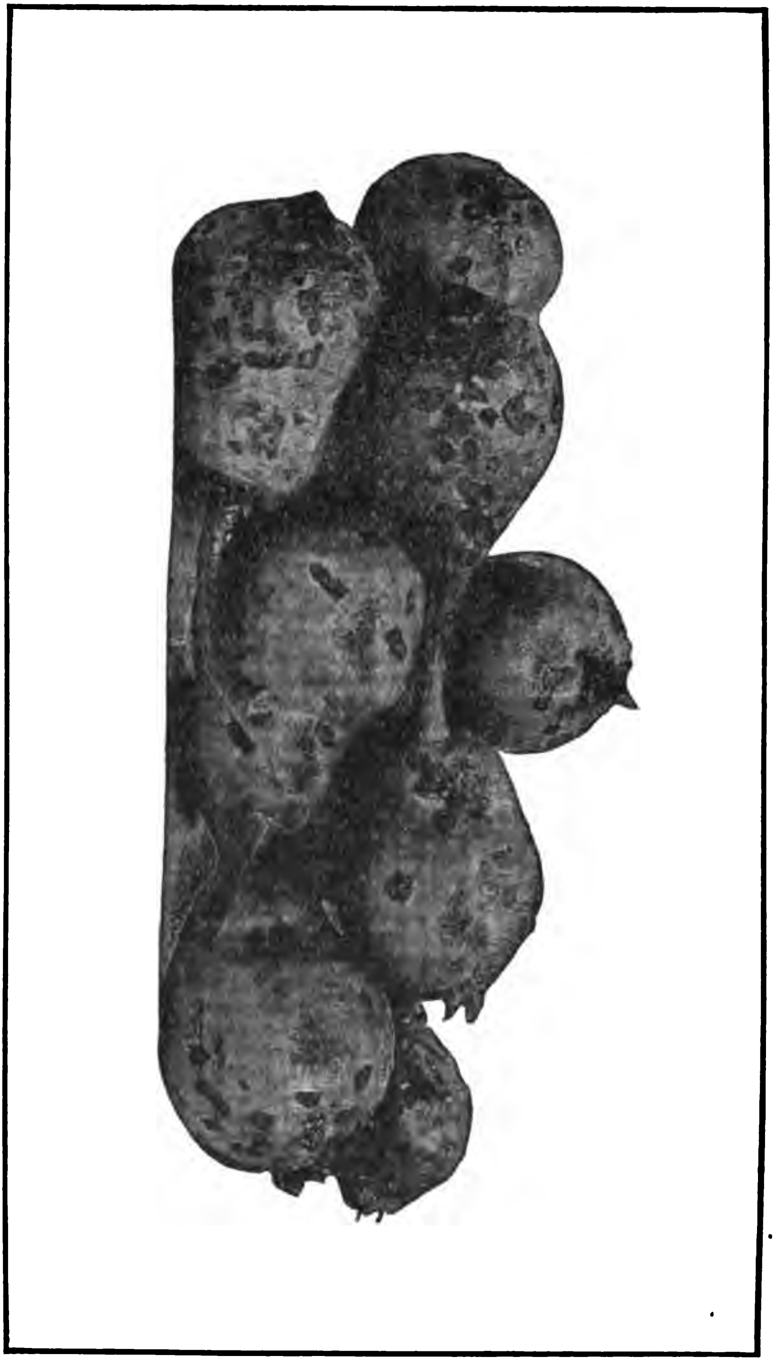


FIG. 30.— CLUSTER OF PEARS INJURED BY THE FALSE TARNISHED PLANT BUG.

Treatment. No satisfactory means for the prevention of losses

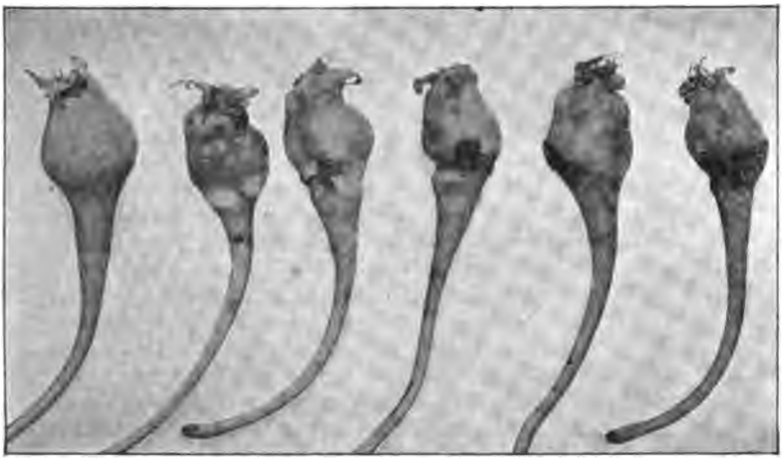


FIG. 31.— THE PEAR MIDGE: YOUNG PEARS DEFORMED BY LARVÆ.

to the crop have been devised, and it is fortunate that the insect is of rather local importance. For the protection of a few trees it is desirable to collect and destroy by the middle of May all infested fruits, which may be distinguished by their size and shape. For commercial plantings the only recourse is frequent and thorough cultivation during June and July.

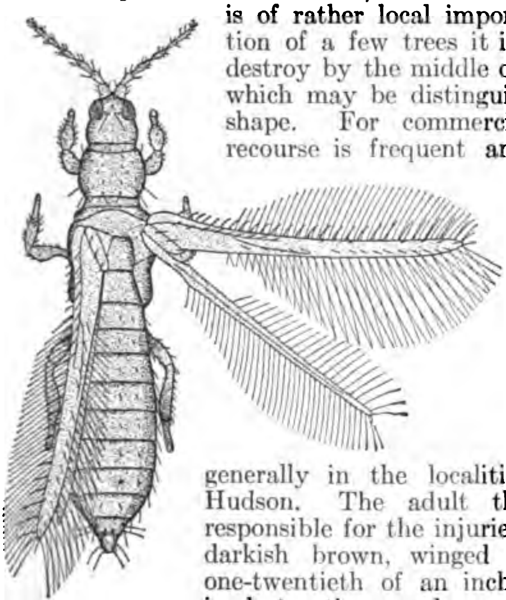


FIG. 32.—THE PEAR THRIPS: ADULT. (Much enlarged.)

The Pear Thrips.

The pear thrips, *Tæniothrips pyri* Daniel, occurs in all the leading fruit-growing sections of the state. It is most injurious in the Hudson Valley and has attracted the attention of growers generally in the localities of Germantown and Hudson. The adult thrips, which is largely responsible for the injuries to the trees, is a small, darkish brown, winged insect measuring about one-twentieth of an inch in length. It appears in destructive numbers when the buds are opening, attacking the tenderest of the flower parts. While all fruits are subject to attack, pears of

the varieties Kieffer and Seckel sustain the greatest damage. In severe attacks the trees are wet with sap, which runs down the fruit spurs, discoloring the bark, while bud scales, blossom bracts, and sepals of unopened blossoms become blackish or discolored. At time of full bloom, trees severely injured appear as if struck by blight. The eggs are mostly deposited in the blossom and fruit stems. Hatching takes place in a few days, and after feeding for about two weeks the larvæ drop to the ground. In a protecting cell, the insect completes its transformations and emerges from the ground in spring as an adult.

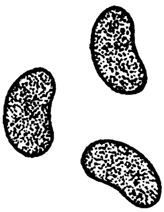


FIG. 33.— THE PEAR THRIPS: EGGS. (Enlarged.)

Treatment. The thrips is a difficult pest to combat because of the nature and suddenness of its attacks. Spraying is the most efficient method of control. The period for effective spraying is during the time when buds are breaking and until they are entirely opened at the tips. The most efficient mixtures are nicotine preparations in combination with an oil emulsion or soap. A very satisfactory formula is three-fourths pint of nicotine solution (40 per ct.) in one hundred gallons of water, adding from two to five pounds of soap. Apply the spray in liberal quantities as a rather coarse, driving spray, holding the nozzle fairly close to the buds in order to force the liquid into the ends of the buds. When petals drop, the treatment should be repeated to destroy the larvæ. Considerable protection may be afforded to the trees by a heavy application of a whitewash as buds are beginning to break at the ends. The white wash is made by slaking eighty pounds of quicklime for each one hundred gallons of wash. This should be strained through fine brass screening before applying.

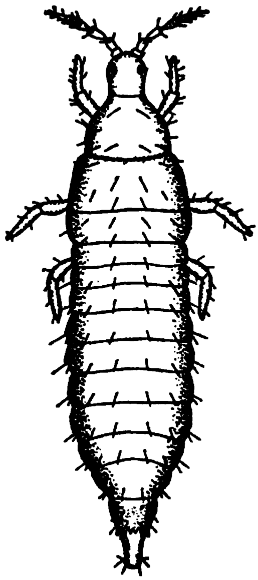


FIG. 34.— THE PEAR THRIPS: LARVÆ. (Enlarged.)

The Plum Curculio.

The curculio, *Conotrachelus nenuphar* Herbst., causes deformed and knotty pears. It also produces holes in the maturing fruit that are often confused with the work of the codling moth. The adult is a small gray beetle that passes the winter under the bark of trees or under rubbish. This insect appears early in spring and deposits its eggs in young fruits. The egg is inserted under the skin,

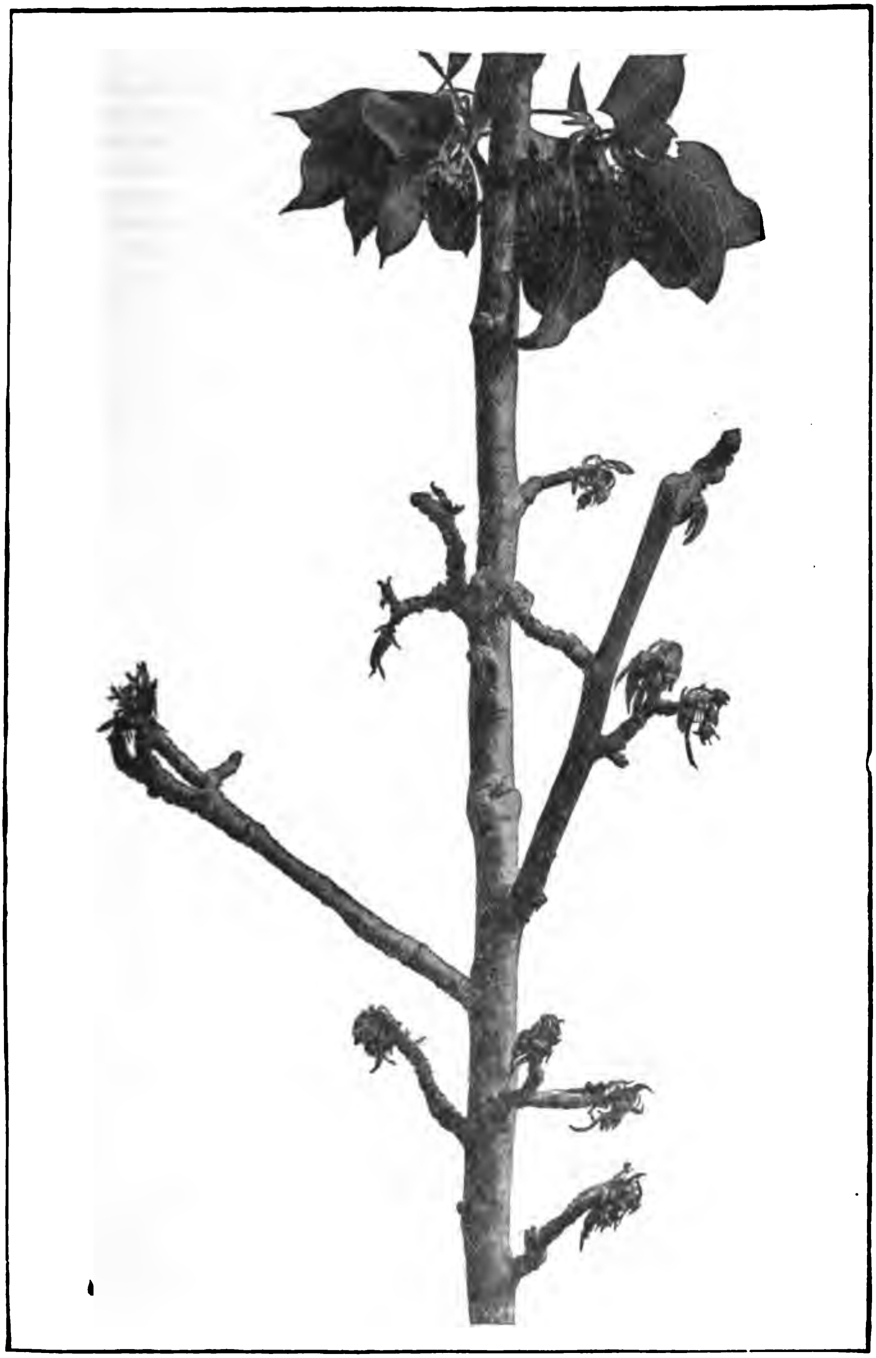


Fig. 35.— Kieffer Branch Showing Blighting of Blossom Clusters Due to Work of Thrips.

after which a crescent-shaped cut is made around one side of the puncture. Egg laying continues for about two months.

Treatment. The plum curculio is rarely injurious to commercial plantings of pears in New York, except where the orchard is adjacent to woods, brush land, or other favorable hibernating quarters, or to plantings of plums and peaches. The most effective means of combating this pest in pear and apple orchards are: spraying with lead arsenate, clean cultivation, tillage, and destruction of windfalls. It is possible to reduce the numbers of the insects in nearby plantings of plums and peaches by jarring the plum or peach trees

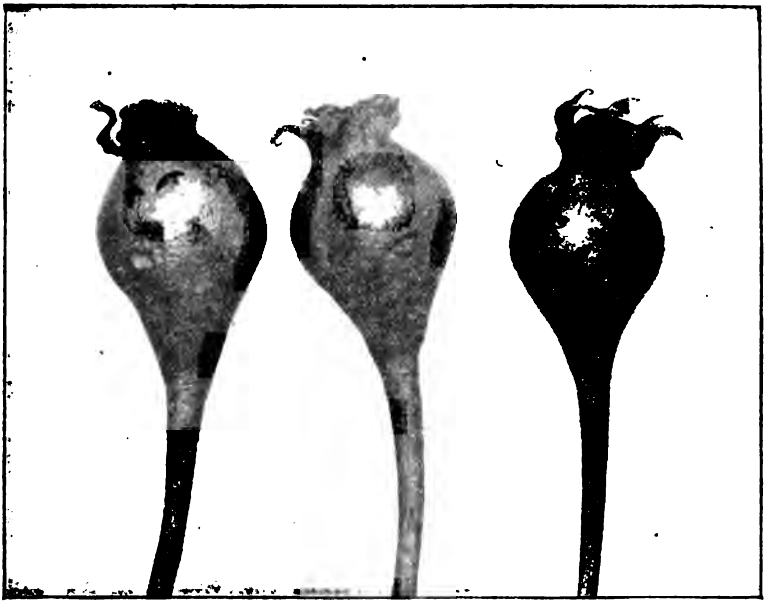


FIG. 36.— THE PLUM CURCULIO: YOUNG PEARS SHOWING FEEDING AND OVIPOSITION PUNCTURES.

or by spraying with arsenate of lead just after blossoming. If the infestation is due to the close proximity of woods or waste lands, such places should be cleared of the underbrush or burned over during the winter so as to destroy hibernating insects.

The Bud Moth.

The larva of the bud moth, *Tmetocera ocellana* Schiff., hibernates over winter under a tiny shelter on the young wood, and in spring attacks the opening buds. Later, when leaves and blossoms unfold, it seeks the clusters, forming a retreat in the

webbed leaves. By reason of its destructiveness to buds and blossoms, the bud moth is a serious pest during some seasons. The caterpillar is darkish red in color and pupates in June. The moth makes its appearance about ten days later, and soon afterward eggs are deposited for the next year's brood. From these eggs, caterpillars hatch that feed on the leaves until fall, when they seek sheltered retreats for the winter.

Treatment. Systematic spraying with arsenicals each year will control this species. The times for effective spraying are, first, as the buds begin to expand, and, secondly, when the leaves are fairly out.

The Leaf Rollers.

The oblique-banded leaf roller, *Archips rosaceana* Harris, and the fruit-tree leaf roller, *Archips argyrospila* Walker, are native insects that feed on a variety of fruits, such as pear, apple, peach, plum, and cherry. These insects also attack various shade and forest trees. The leaf rollers are destructive to fruit trees during some seasons because of their work on blossoms, young fruits, and foliage. The oblique-banded leaf roller attacks young pears as soon as they set and continues feeding on them until the fruit attains nearly an inch in diameter. They eat large round holes, sometimes extending to or even beyond the core. The larva of the fruit-tree leaf roller appears as the buds are bursting and feeds on the unfolding leaves. The leaves and blossom clusters are tied together in a web, within which the larvæ feed. The injury to the fruit is similar to that described for the above associated species. The caterpillars mature in June, and the moths appear about one month later. The fruit-tree leaf roller deposits its eggs on the bark of the trunk and twigs, where they remain through the winter.

Treatment. Very careful and thorough spraying with arsenate of lead (three pounds to fifty gallons of mixture) should afford satisfactory protection. The first application should be made shortly after the eggs begin to hatch, which will be when the first green foliage is showing on the trees, and the second as soon as the blossom buds have separated in the clusters. The fruit-tree leaf roller has proved a difficult insect to control. Arsenate of lead should be applied as recommended for the associated species. Recent experiments indicate that the insect may be efficiently combated by thorough spraying, just before buds open, with miscible oil diluted with fifteen parts of water.

The Green Fruit Worms.

The green fruit worms, *Xylina spp.*, sometimes do serious injury by eating into the young pears. They also attack apples, plums, cherries, peaches, and quinces. The full-grown caterpillars measure from an inch to nearly an inch and a half in length. They are

green or yellowish green in color with various irregular markings and stripes, the most prominent of the latter being a narrow, cream-colored stripe down the middle of the back and a wider one along each side. The caterpillars are most destructive during May, soon after the fruit has formed. They continue feeding until about the middle of June. They feed mostly at night, resting on the undersides of the leaves during the day. When full-grown, they go into the ground, form a rough cocoon, and pupate. The adults are dull-

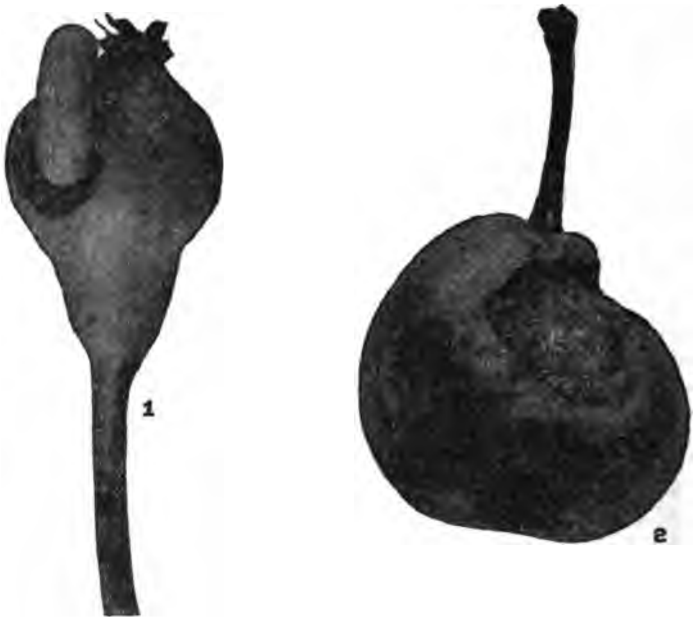


FIG. 37.— THE GREEN FRUIT WORM: (1) CATERPILLARS EATING YOUNG PEAR; (2) MATURE PEAR SHOWING EFFECTS OF INJURY.

colored moths, measuring about two inches from tip to tip with the wings spread. They lay their eggs in spring, and the caterpillars appear during the early leafing period.

Treatment. These insects are difficult pests to combat when once they have acquired a taste for the young fruits. They are, however, much less destructive in orchards that are well sprayed each year and given careful attention in other respects. Observations indicate that the most satisfactory means of protecting the crop is thorough spraying with arsenicals before blossoming and after petals drop. Cultivation is unquestionably fatal to many of the pupæ in the ground.

INSECTS THAT ATTACK THE FOLIAGE.

The Pear Psylla.

Probably the most troublesome insect attacking the pear is the pear psylla, *Psylla pyricola* Förster. These tiny insects are similar in many ways to aphides and are sometimes called jumping plant lice. Like plant lice, they are sucking insects, and multiply rapidly, so that unless checked, they make up in numbers what they lack in size and may injure the trees very severely. A number of broods are produced in summer, and the adults that live through the winter are quite distinct from the summer adults. They appear early in spring and deposit their eggs in protected places on the bark. The eggs hatch in about three weeks, and the little larvæ, or nymphs, at once begin to suck the juices from the young leaves and twigs. A favorite place for the young nymphs is in the axils of the leaves and at the bases of the fruit stems. Within two or three days after hatching they cover themselves with honeydew, which finally becomes very abundant. The leaves become stunted and sometimes fall, and the fruit ceases to grow in size and may drop prematurely if the work of this first brood is continued by the later broods. In long-continued attacks the trees may become almost defoliated, and the new leaves, if they appear, are generally few in number and pale in color. With the injury caused by the draft on the sap of the tree, there is joined an external disfigurement of both leaves and wood due to the copious secretion of honeydew by the psylla, which serves as food for the sooty fungus. Growth of this fungus soon gives the wood a smutty, discolored appearance and darkens and stains the leaves. If the attacks of psylla are severe, the trees go into winter in a weakened state and succumb much more readily to low temperatures than do uninjured trees. Renewed attacks, year after year, so lessen the vitality of the trees that they become unproductive.

FIG. 38.— THE PEAR PSYLLA: ADULT.

FIG. 39.— THE PEAR PSYLLA: EGGS.

Treatment. During seasons when it is superabundant the psylla is greatly feared, although most growers fail to protect their orchards. The causes for failures are not always apparent, but spraying practices with many orchardists are usually faulty in that there is no systematic treatment of the trees, and directions for spraying are not always correctly interpreted or carefully followed. For orchards annually subject to attack the following measures are recommended:

FIG. 40.— THE PEAR PSYLLA: LARVA. (Enlarged.)

1. Practice clean culture so as to prevent flies from wintering in accumulations of matted leaves and weeds.

2. Remove rough bark in order to discourage flies from wintering on the trees and to render them more exposed to spraying mixtures. Bark is more easily detached immediately following a wet period. Care should be taken not to cut into the live tissues.

3. Spray thoroughly to kill the flies with nicotine solution (40 per ct.) using three-fourths pint to one hundred gallons of water and three pounds of soap, preferably during a warm spell in November or December, or during March or early April. Select a day when the mixture will not freeze on the trees. Some growers prefer a miscible oil, using one gallon diluted with fifteen gallons of water. This treatment should be made only in spring before the buds open and on days when there is no danger of freezing of the spraying mixture.

4. Spray trees thoroughly with the lime-sulphur mixture at winter strength so as to destroy the eggs. This treatment should be made during the latter part of April or early in May, or just before the cluster buds separate at the ends.

5. Spray the trees thoroughly just after blossoms drop, in order to kill the newly-hatched nymphs, with nicotine solution (40 per ct.), using three-fourths of a pint to one hundred gallons of water and three pounds of soap or kerosene emulsion diluted with eight parts of water. Direct the spray into the axils of the leaves and fruits, and wet both surfaces of the leaves.

If the work is well done, it is not necessary to carry out all of these measures each year. If the trees have been carefully scraped, a combination of treatments 3 and 4 or 3 and 5 should be sufficient. Some growers have entirely controlled the psylla with treatment 3 alone, to kill the hibernating flies. Where adjacent orchards are neglected, however, it may be necessary to make applications during the summer so as to control invaders from such unsprayed plantations. In this event frequent and thorough spraying with nicotine solution and soap is advised.

The Pear Slug.

The larvæ of this species, *Eriocampoides limacina* Retz., are small, shiny, dark green or almost black, sluglike creatures that feed on the upper surface of the leaves, leaving the skeleton of veins and the lower epidermis, which turn brown and wither. There are two broods during the year. This insect appears in destructive numbers only in occasional years.

FIG. 41.— THE PEAR SLUG: LARVA AND WORK ON LEAF (after Webster).

Treatment. Apply arsenate of lead, two pounds to fifty gallons of water, as soon as the pests are detected. Dusting of foliage with freshly slaked lime also affords efficient protection from the insect.

The Blister Mite.

The blister mite, *Eriophyes pyri* (Pgst.) Nal., is responsible for dark brown or blackish patches, or blisters, of various sizes that may cover much of the leaf and sometimes cause it to rupture in one or more parts, especially along the margins. The mites burrow into the leaves from below, and the irritation they cause induces the growth of galls. These at first are greenish pimples with a more or less reddish tinge. The color strengthens as the

FIG. 42.— THE BLISTER MITE: ADULT. (Enlarged.)

galls enlarge, appearing as dead areas of varying size. The galls also show one or more tiny openings — the tunnels or burrows made by the mites on entering and leaving the leaf. The mites spend the winter in the buds, usually under the second and third layers of bud scales. They frequently collect in colonies of fifty or more in little depressions in the scales and are more or less concealed and protected by the pubescence of the buds. As the buds burst, the mites move to the unfolding leaves, in which they burrow and establish new colonies. In October the mites abandon the leaves and hide in the buds.

fed upon extensively, curl and the greater portion of the leaf surface dies although portions of the leaf near the veins usually remain green. Occasionally the insects attack the fruit. The most extensive feeding occurs on young trees or older trees that are weakened from other causes.

The beetles mate and eggs are laid during June and early July and these are placed in the soil at the bases of the trees upon which the beetles feed. These eggs are often scattered in the rubbish on top of the ground but they may also be found in the soil to a depth of about one inch. Some eggs are glued to the bark at the base of the tree. The eggs are yellowish, almost spherical in shape, and measure about .03 inch in length. The eggs hatch in from two to three weeks, the first larvæ appearing during the last week in June.

The larvæ are dark brown with head, thoracic shield and anal segment black. They attain a length of from one-fourth to one-third of an inch and feed on the foliage of the bird cherry. They appear to be unable to mature on foliage of the cultivated cherry.

The pupa is yellow with numerous brown pointed spines on the head and body. The pupal stage is passed in the ground during the latter part of July. The adults appear during the last week of July and during August and, after slight feeding, they seek winter quarters in rubbish near their food plants.

REMEDIAL MEASURES.

Since the larvæ of the cherry leaf-beetle do not thrive on the foliage of the cultivated cherry but apparently feed entirely on the wild bird cherry, no means of combating the pest during this stage is known. The most practical method that has been devised for protecting cherries and peaches is to spray the trees as soon as the beetles appear. On cherry trees, applications of 8 pounds of paste arsenate of lead with 100 gallons either of water or of bordeaux mixture (8-8-100) has proven very efficient. In spraying, great care should be exercised to cover the foliage thoroughly, both on the upper and lower surfaces, with the material. Paste arsenate of lime in the proportions of 6 pounds to 100 gallons of water, or with bordeaux mixture as above, proved in our experiments equally effective. This arsenical should be used experimentally since there is some doubt as to its safeness on foliage of fruit trees.

Nicotine sulphate (40%), one-half pint in 60 to 80 gallons of water, is an effective contact spray. In using it one should first direct the treatment to the foliage and then thoroughly spray all beetles which have dropped to the ground. On account of its safe properties nicotine solution may be employed without danger of injury to peach foliage. Arsenate of lead sometimes causes injury to peach leaves, and in its use on this fruit great care should be exercised.

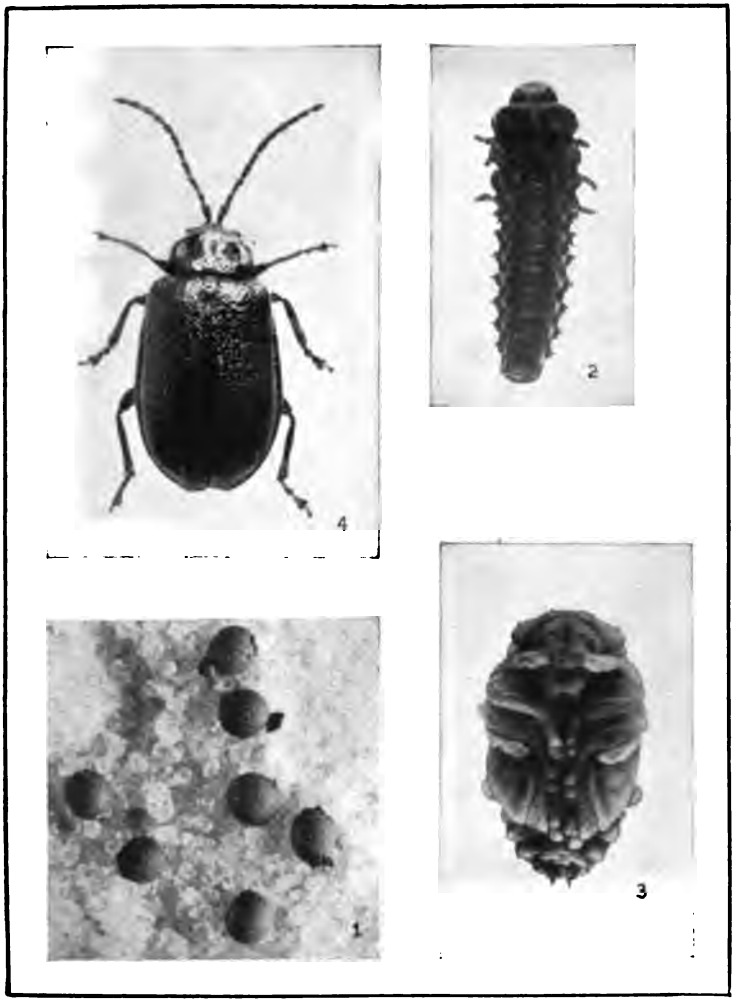


PLATE LXIII.— LIFE STAGES OF CHERRY LEAF-BEETLE.
1, Eggs; 2, larva; 3, pupa; 4, adult.

Plate LXIV.— Work of Cherry Leaf-beetle on Cherry Foliage.

Since the beetles may quickly defoliate young trees before an arsenical poison has time to kill the insects, jarring the beetles into sheets and destroying them is to be recommended when the infestation is serious.

PERIODICAL CICADA IN 1916.*

P. J. PARROTT AND H. E. HODGKISS.

Interest in the periodical cicada is chiefly two-fold: its curious life history and habits, most striking of which are its sojourn of seventeen years in the ground and the great numbers of the creatures that may appear in a restricted area; secondly, its destructiveness to newly-planted orchards and vineyards. As Brood VII of the insect is scheduled to appear soon in certain counties in western New York, this circular has been prepared to notify orchardists of the probable occurrence of the cicada this summer, and to solicit information from farmers generally as to dates of its appearance, distribution and local importance.

DISTRIBUTION IN NEW YORK.

This brood may be expected to occur largely throughout western New York where previous records indicate its reappearance in the counties of Cayuga, Livingston, Madison, Monroe, Onondaga, Ontario, Wyoming and Yates. During its occurrence in 1899 individuals of this brood were reported in greater or less numbers from the following localities: In Monroe County, on the northeast shore of Irondequoit Bay, and in the vicinity of Webster; Livingston County, Geneseo and Sonyea; Ontario County, Manchester, Victor, Padelfords, Farmington, Bloomfield, East Bloomfield and Billsboro Station; Yates County, Earl, May's Mills and Dresden and points between; Cayuga County, Union Springs and points extending about three miles north, three miles west and seven and one-half miles south; Madison County, Chittenango and vicinity; Onondaga County, Syracuse, Onondaga, and points south in the Onondaga Valley. Doubtless there are many other localities in the State where this brood is established and have so far not been recorded.

LIFE HISTORY.†

The life history of the periodical cicada does not differ materially from that of many other species of insects except for the long life under the ground. There are many others that are known to live nearly a year in the soil, and a few, such as the common white grub, the larva of the May beetle, are about three years in the ground before emerging; but no other insect known can equal the periodical cicada for longevity.

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* A reprint of Circular No. 50, May 15, 1916.
† From Bulletin No. 212 of this Station.

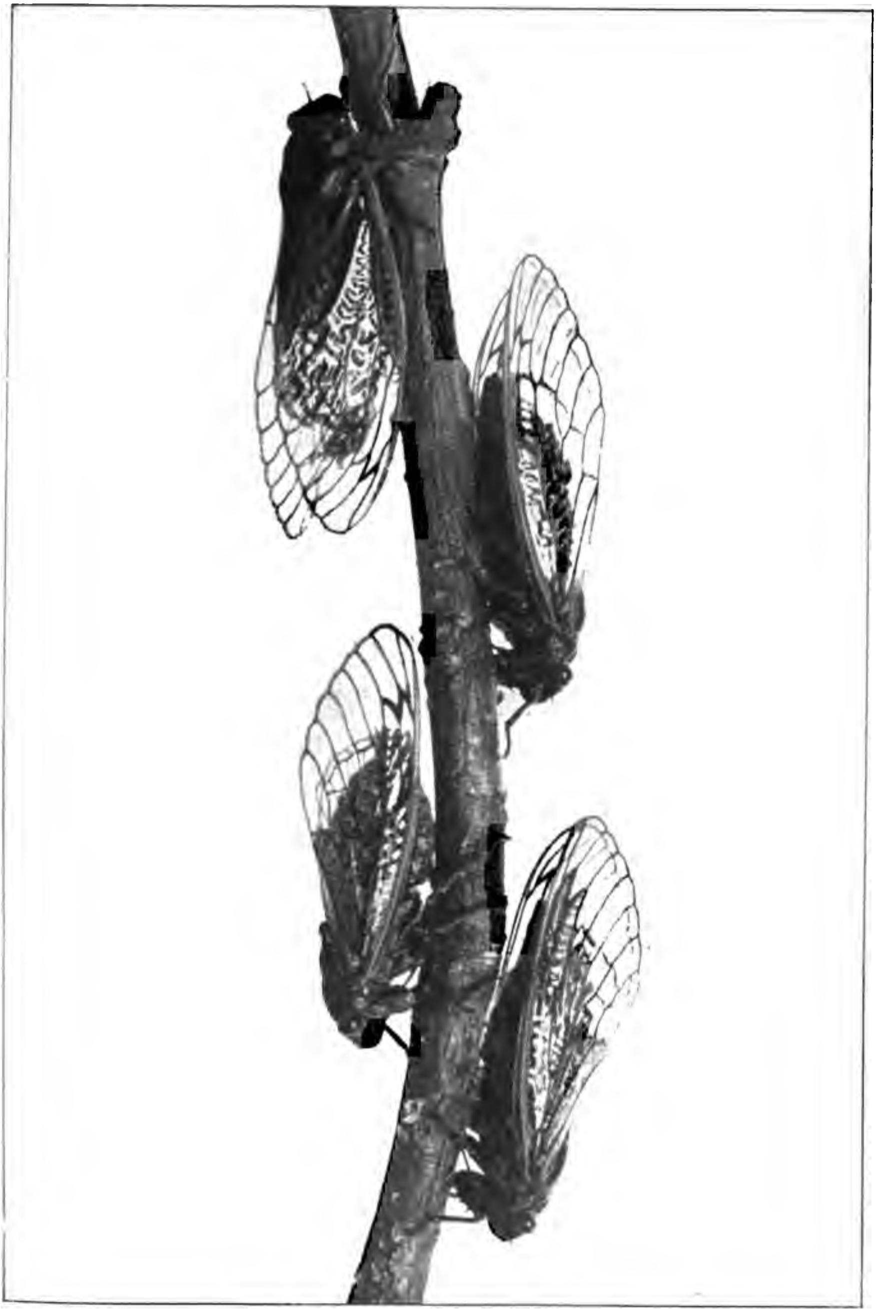

Plate LXV.— Periodical Cicadas.
(Enlarged.)

of trees, shrubs and vines, but so little is required for their slow growth that, except in occasional instances where they are unusually abundant, it is not probable that appreciable injury is done. The important injury is caused by the females in laying their eggs in the twigs. Frequently the twigs and smaller limbs are so weakened by the punctures of the female as to break off with the slighest wind. Large trees may withstand this injury without serious consequences, but small trees of a few years' growth are often seriously injured.

The extent to which young trees may be injured was well illustrated along the western shore of Seneca Lake by the brood which appeared during the spring of 1899. In one orchard in the vicinity of Earl, several young plum and cherry trees were badly broken as a result of the punctures of the females (Plate LXVI). Another case near Dresden was that of a small vineyard in which the cicadas appeared in large numbers. By June 9, nearly all of the vines were badly broken and in most cases the new growth wilted. An examination showed that the cicadas had selected the growth of the previous year in which to deposit their eggs, thus causing the new growth to wilt and finally die. As a result of the attack this vineyard produced very little fruit that year. Old wounds caused by deposition of the eggs afford lodgment for other insects, especially the woolly aphis, thus resulting in a secondary injury which may be of a serious nature.

METHODS OF CONTROL.

Spraying of emerging pupæ with home-made or commercial oil-emulsions is fatal to them. When occurring in large numbers there seems to be no practical method of controlling the adults except over very small areas. Experiments with pyrethrum, kerosene emulsion and various acids have shown that all of these substances have some effect, but are probably of little practical value. Small trees, shrubs and vines can be protected from the adults by covering them with sheeting, cheesecloth, wire netting, or by systematic collection of the insects each day after their first appearance. This, of course, would be practical only in the case of a few choice plants. According to Marlatt recent experience indicates that trees thoroughly sprayed with bordeaux mixture or a lime wash are apt to be avoided by the cicada, especially if there are other trees or woods in the neighborhood on which they can oviposit. As a means of reducing the numbers of a brood in any locality the pruning of branches in which eggs have been deposited, if done in time, will prove effectual. The injured branches should be cut out soon after the eggs are deposited. As a further precaution against injury by the adults, young stock should not be planted during the two years previous to their appearance in those localities where the insect is known to occur.

THE SEASON'S EXPERIENCES WITH THE PERIODICAL CICADA.

Recipients of this circular are requested to report on the activities of this insect during the coming month in their locality. Information is especially solicited bearing on the dates of first appearance and disappearance of the cicadas, relative abundance, the conditions of their occurrence, whether in woodlands, orchards or vineyards, and extent of injuries in fruit plantings.

REPORT

OF THE

Department of Horticulture.

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(Connected with Grape Culture Investigations.)

TABLE OF CONTENTS.

I. Some notes on the breeding of raspberries.
II. New or noteworthy fruits, IV.
III. New or noteworthy fruits, V.
IV. Culture and forcing of Witloof chicory.
V. Culture of cabbage.

[1] Resigned October 1, 1916.

REPORT OF THE DEPARTMENT OF HORTICULTURE.

SOME NOTES ON THE BREEDING OF RASPBERRIES.*

R. D. ANTHONY,
UNDER THE DIRECTION OF
U. P. HEDRICK.

SUMMARY.

The breeding of raspberries was begun at this Station nearly a quarter of a century ago. At first the work was largely confined to the red raspberry and a number of excellent seedlings were secured from various combinations of Marlboro, Loudon and Superlative. Since 1910 greater attention was paid to the black-cap and purple raspberries. About 3300 seedlings were tested.

It was to set at rest any doubts which might remain as to the hybrid origin of the purple raspberry, Peck's *Rubus neglectus,* and to secure better varieties of this popular sort that the breeding of the purple raspberries was undertaken. The work has shown beyond a doubt that these originated as hybrids of the black-cap and red raspberry. Some very promising seedlings have been secured.

Pure seedlings of Columbian, an F_1 hybrid, failed to break up as much as would be expected. None showed any tendency to propagate by suckers nor did any have fruit of the color of either parent. In cane color and glaucousness some of the seedlings approached more nearly the parent types.

Hybrid seedlings were produced by crossing two black-caps with a red raspberry. With one cross the seedlings were all purple; among the 289 seedlings of the other cross were 10 yellows. None propagated by suckers.

In order to find which varieties are the best parents, a study was made of the performance of various varieties. The record of Marlboro, Herbert, Cumberland and Smith No. 1, a seedling black-cap of unknown origin, is given.

* A reprint of Bulletin No. 417, March, 1916.

A study of the inheritance of color of fruit would indicate that several of our black raspberries are heterozygous for color and that probably several color factors are present. The same thing holds with the red raspberry though the higher number of yellows would indicate fewer color factors. Selfed seedlings of Columbian gave one yellow, one black and forty that were probably varying degrees of purple. A black-cap which was pure for color produced only purples when crossed with a red containing a factor for yellow, but when both were heterozygous yellow hybrids were produced.

Glaucousness, the presence of bloom on the canes, is probably a dominant character. Both the Columbian seedlings and the F_1 hybrids gave glaucous and non-glaucous bushes in a ratio very nearly three to one.

The F_1 hybrids could also be separated in the ratio of three with rough bark to one with smooth bark.

The analysis of the inheritance of spines is inconclusive though certain similarities in the results secured from the purple seedlings suggest the desirability of further study along this line.

Three of the Columbian seedlings produced some unusual abnormalities in the flower clusters. There were many gradations from perfect fruits to those in which the drupelets were replaced by small, sepal-like leaves. In other clusters the fruits varied from perfect to entirely sterile forms which did not have the leafy growth.

All the purple raspberries having Smith No. 1 as the female parent were standard plants but nearly one-third of the Cumberland seedlings were dwarfs. The factor for dwarfing is evidently one of rather rare occurrence.

From a correlation which was found between leaf coloration and fruit it would seem that it is entirely possible to tell all yellow raspberries from either the red or purple sorts by the absence of any tinge of red on the leaves. It is probably true also that the bark of the young canes of the yellow varieties is entirely lacking in any touch of red or purple color.

The Herbert red raspberry and the Blowers blackberry were pollinated by the flowering raspberry, ***Rubus odoratus***. The Blowers seedlings were lacking in vigor and all died the first year. The Herbert seedlings made a strong growth and in 1915 blossomed freely. A study of these leaves no doubt as to their hybrid origin. In ***Rubus odoratus*** we may have a go-between through which we

may mix the blood of several of our species. This work of hybridization will be continued with many other species, of which there are now nearly fifty growing on the Station grounds.

HISTORY OF THE WORK.

The breeding of red raspberries was begun at this Station as early as 1892. In 1897 and '98, Marlboro, Loudon and Superlative were used as parents—which proved a fortunate selection, as five seedlings out of a total of nearly 1200 have since been named and distributed. Two of these five, June, a seedling of Loudon by Marlboro, and Marldon, from the reciprocal cross, have proved unusually promising early varieties. The other three, Louboro and Donboro, seedlings of Loudon by Marlboro, and Marlative, a seedling of Marlboro by Superlative, are still under test but will probably never be as popular as the two preceding.

During the testing of these seedlings, additional work was not undertaken and it was not until 1906 that other seedlings were bred and then only to test out a few pure seedlings of the five named above.

In 1910 a new series of crosses was begun with the red, black and purple raspberries. June was crossed with other reds and also used as a pollinizer for a black-cap. With the black raspberries, various combinations were made among Cumberland, Eureka, Hilborn, Palmer and a seedling of unknown origin called Smith No. 1. Columbian, the only purple used, was self-pollinated. In 1912 before these seedlings fruited, several of these crosses, including the Smith No. 1 by June, were duplicated and, in addition, Cumberland was crossed with June. The first series fruited in 1913 and the other in 1915. In all, 3300 seedlings were tested.

ACKNOWLEDGMENTS.

From 1910 through the fruiting season of 1913 the work was carried on by Richard Wellington, then Associate Horticulturist. Since his resignation in 1913 the task of continuing the work and preparing the material for this report has fallen upon the author.* Without the aid of O. M. Taylor, Foreman in Horticulture, and

* A preliminary report was made by Wellington at the Tenth Annual Meeting of the Society for Horticultural Science at Washington, D. C., November, 1913.

several of the Assistant Horticulturists it would have been impossible to care for this large number of seedlings and to secure the necessary records.

PURPLE RASPBERRIES.

The purple-cane, or purple-cap, raspberry was first called *Rubus neglectus* about 1869 by Peck, then New York State Botanist. As botanists became more familiar with these raspberries, the wide range in type which they showed and the fact that they were found only in limited numbers and then in the presence of both the red raspberry and the black-cap, led many to surmise a hybrid origin. The possiblity of hybridizing the black-cap and the red raspberry was soon proved and the similarity of such hybrids to *Rubus neglectus* strengthened these doubts as to the correctness of Peck's species.

About 1873 Professor William Saunders, Director of the Central Experimental Farm, Ottawa, Canada, fruited 24 seedlings obtained from a cross of the Doolittle black-cap by the Philadelphia red raspberry. These were all purple-fruited plants propagating by tips. These hybrids seem not to have attracted much attention and but little further work of this type was attempted for many years.

The popularity of the purple raspberries has been increasing rapidly during the last ten years and in some regions they have largely supplanted the black-caps. This has been due to their heavy production and their nearly complete immunity to the anthracnose which has been destroying the black-caps. When we consider that but two varieties, Columbian and Shaffer, are responsible for this development and that these are but chance hybrid seedlings, we realize what an opportunity there is here for the fruit breeder. It was for this reason that this Station in 1910 undertook to remove all doubts as to the origin of the purple raspberries and to produce improved sorts. The study of over fifty pure seedlings of Columbian and over eight hundred crosses of the black-cap by the red rapsberry has now progressed far enough to show conclusively the hybrid origin of Peck's *Rubus neglectus*. Some of these seedlings give promise of new varieties much superior to any now under cultivation.

The pure Columbian seedlings have presented some interesting problems in their failure to break up in the F_2 generation as much as would be expected, most of the characters still showing intermediate types with very few cases where they approach at all closely to either parent. Out of half a hundred none could be described as a

pure red raspberry, though several were somewhat similar to the red parent both in color and in cane characters; nor did any show a tendency to propagate by suckers as does the red raspberry, though some failed to tip readily. In cane color and glaucousness there was more of the expected splitting up, some seedlings having the deep purple-red canes of the Columbian while others had green canes, some having a bloom such as is found on the base of Columbian canes while others were non-glaucous as in the supposed red grandparent. Recent correspondence with a private fruit breeder * who is growing a number of seedlings of Shaffer from unprotected flowers has led the author to suspect that this variety will be found to possess a quite different gametic composition from Columbian and this suggests the advisability of selfing other purples, especially some of the F_2 seedlings.

In producing the F_1 hybrid seedlings, June, a Station seedling red raspberry, has been used as the male and two different black-caps, Cumberland and Smith No. 1, have been used as females. Practically every crossed seedling shows clear evidence of its hybrid origin. The Smith No. 1 seedlings were all purple, though the color showed varying degrees of intensity; but among the 289 Cumberland seedlings there were nine yellows which were intermediates in their bush type and one which might readily have been classed as a black-cap bush. The question of the inheritance of color of fruit will be discussed later. None of the seedlings of either cross gave any indication of propagating by suckers.

An unusually large proportion of these crossed seedlings was very promising. The bushes were more vigorous than either parent and bore a crop of large, firm fruit, somewhat later than the parents. Some fruits were rather unattractive because of their dark color and dull look caused by a thick pubescence but many were of a rich, glossy purple.

For those wishing to breed purple raspberries the best mode of procedure would seem to be to cross the most desirable reds and blacks rather than to attempt inter-crossing among the purples or to grow pure seedlings of any purple sorts. For such persons the chances of reward are excellent and as results can be secured in from three to four years — a comparatively short time for the fruit breeder — this offers an attractive field.

* Letter December 6, 1915, from Henry Tiedemann, Hammond, Ind.

PERFORMANCE OF CERTAIN VARIETIES USED AS PARENTS.

A short time ago Hedrick and the writer in a discussion of some grape-breeding studies * called attention to the advisability of finding those varieties which are desirable parents as a means of hastening the production of improved sorts. This same factor needs emphasis in the breeding of raspberries. In a comparative test in the commercial plantation Cumberland would probably be ranked ahead of Smith No. 1, yet, when these were both pollinated by the same red raspberry, 12 per ct. of the resulting Cumberland seedlings were saved as worthy of a second test — a high proportion as breeding work goes — while 24 per ct. of the Smith No. 1 seedlings were saved. It is for this reason that the following rather meager information is given for the varieties which have been used most extensively.

Marlboro.— During the first fifteen years this variety was used in a large number of crosses and more than one hundred seedlings having Marlboro as a parent or grandparent have been marked as worthy of retaining for further testing. Many of these have since been discarded but several are very promising. In general, Marlboro seedlings are early — frequently earlier than the parent — of good size, sometimes too soft for long shipment and frequently lacking in high quality. Yellow seedlings may be expected in small numbers.

Few Marlboro seedlings are rampant plant makers and the bushes are more inclined to be stocky than sprawling. This variety appears to possess a factor for spinelessness, a few spineless plants appearing in several of its crosses. June, one of its seedlings out of Loudon, is more nearly spineless than most raspberries. In 1915 sixty-six seedlings of Marlboro by June were fruited. This combination of parent and progeny seems to have accentuated this factor, since 27 plants were graded as spineless or with only a few at the base of the canes; of the others, 28 had spines only on the mid-rib of the leaf, while 4 had a few and 4 a medium amount on the canes.

Of the above seedlings, 29 per ct. were marked worthy of a second test. This speaks well for Marlboro which was both a parent and a grandparent.

* Inheritance of certain characters of Grapes. N. Y. Agr. Expt. Station Tech. Bul. 45.

Plate LXVII.— A Typical Purple Hybrid.

Plate LXVIII.— One of the Most Promising Red Raspberry Seedlings.
(June × Herbert.)

Plate LXIX.— A Promising Black-cap Seedling.
(From Smith No. 1.)

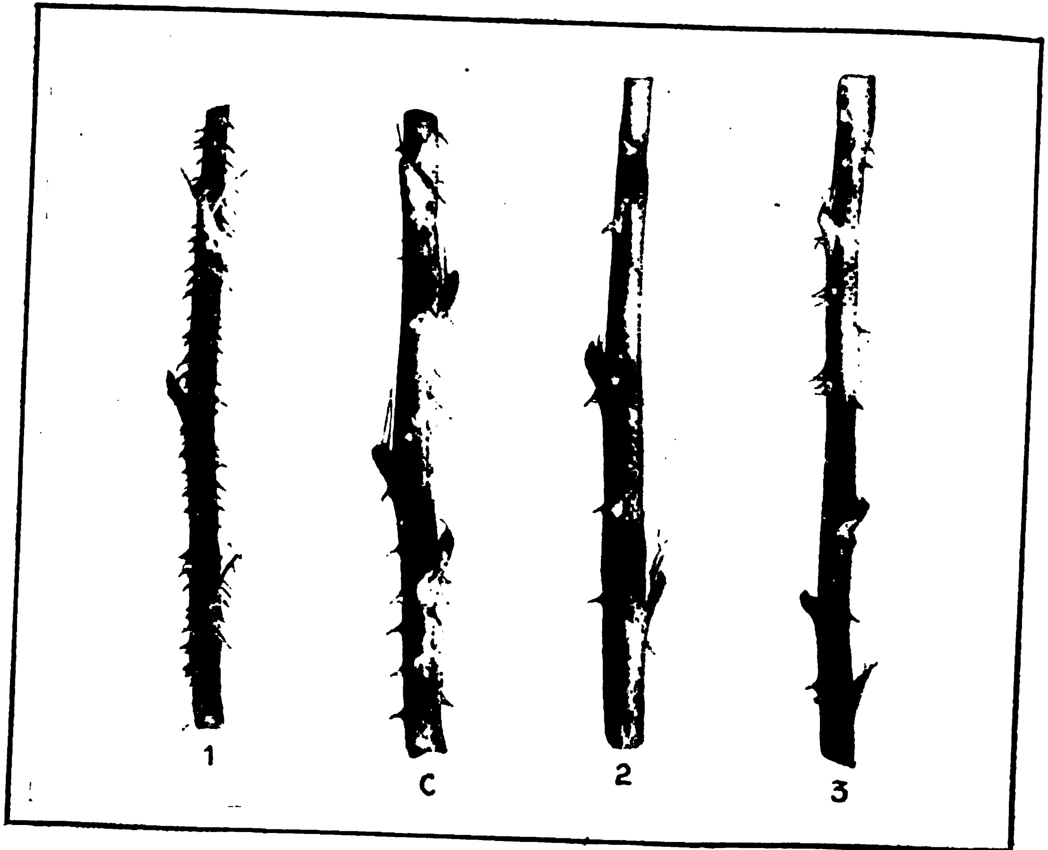

PLATE LXX.—SPINE TYPES AMONG COLUMBIAN SEEDLINGS:
C, The parent; 1, very spiny; 2, few spines; 3, an intermediate.

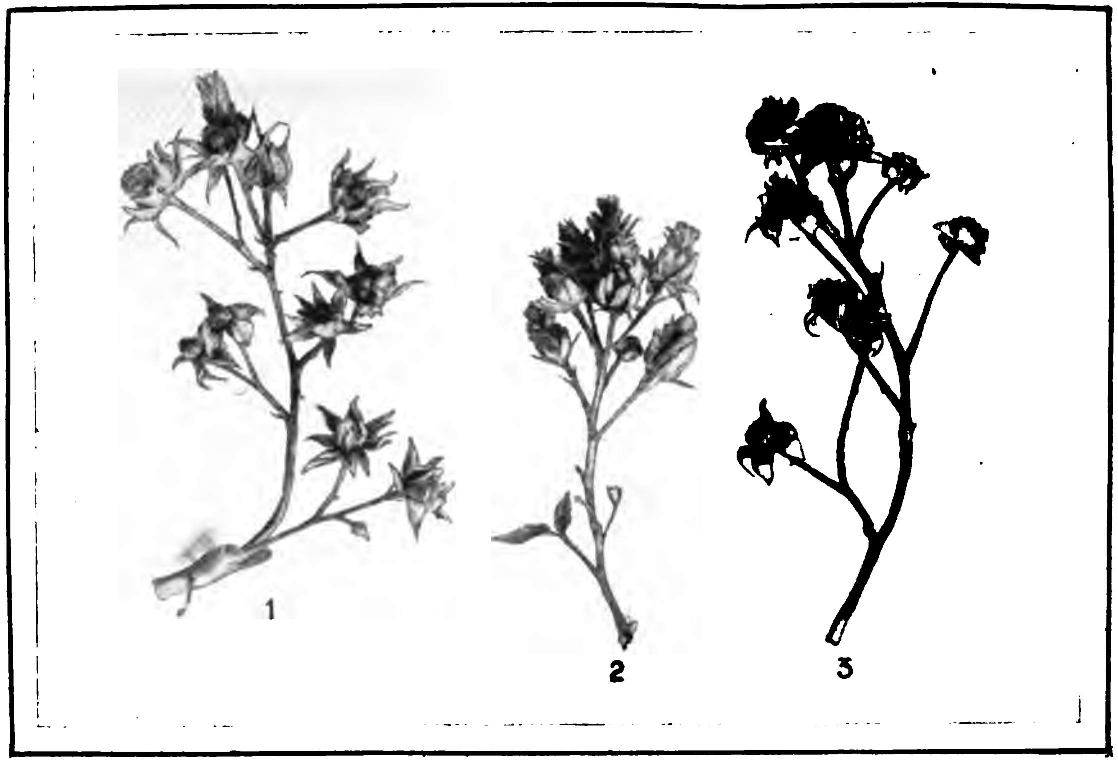

PLATE LXXI.— THREE TYPES OF ABNORMAL CLUSTERS:
1, Varying amounts of imperfectness; 2, leafy type; 3, only the terminal perfect.

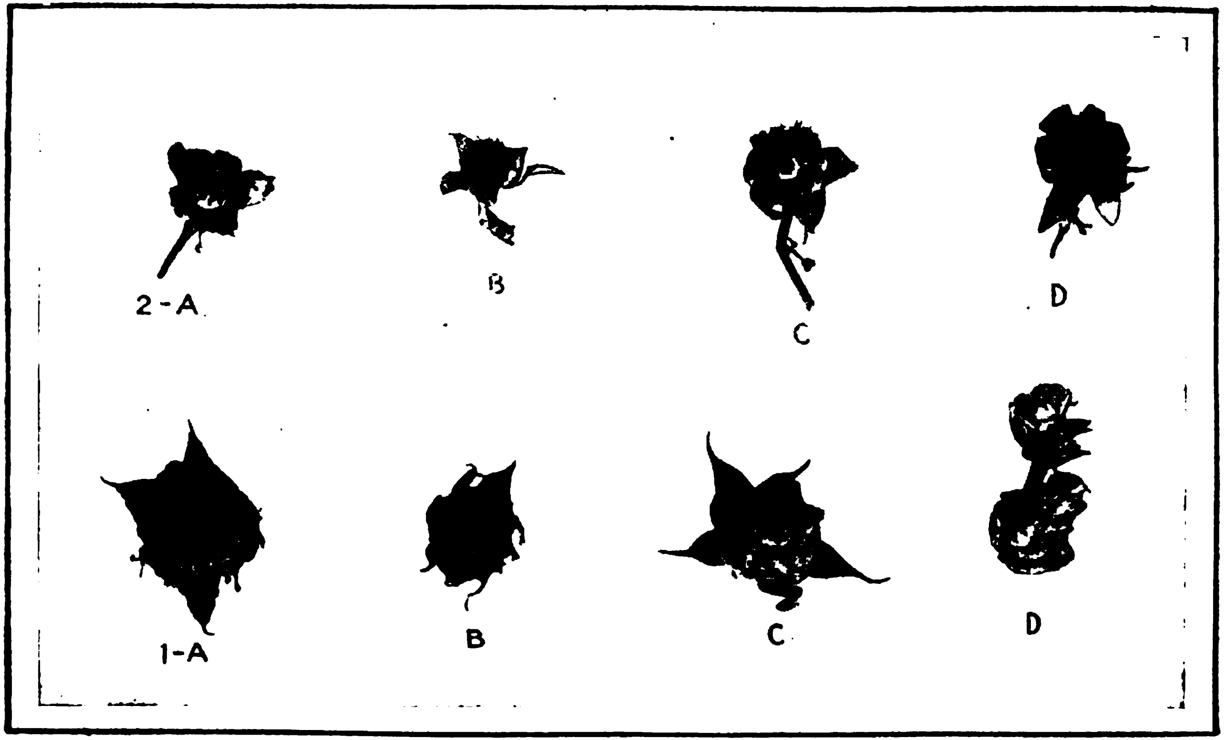

PLATE LXXII — ABNORMAL FRUITS:

Row 1. Perfect fruit (A) and leafy types.
Row 2. A sterile fruit (A) and intermediate forms.

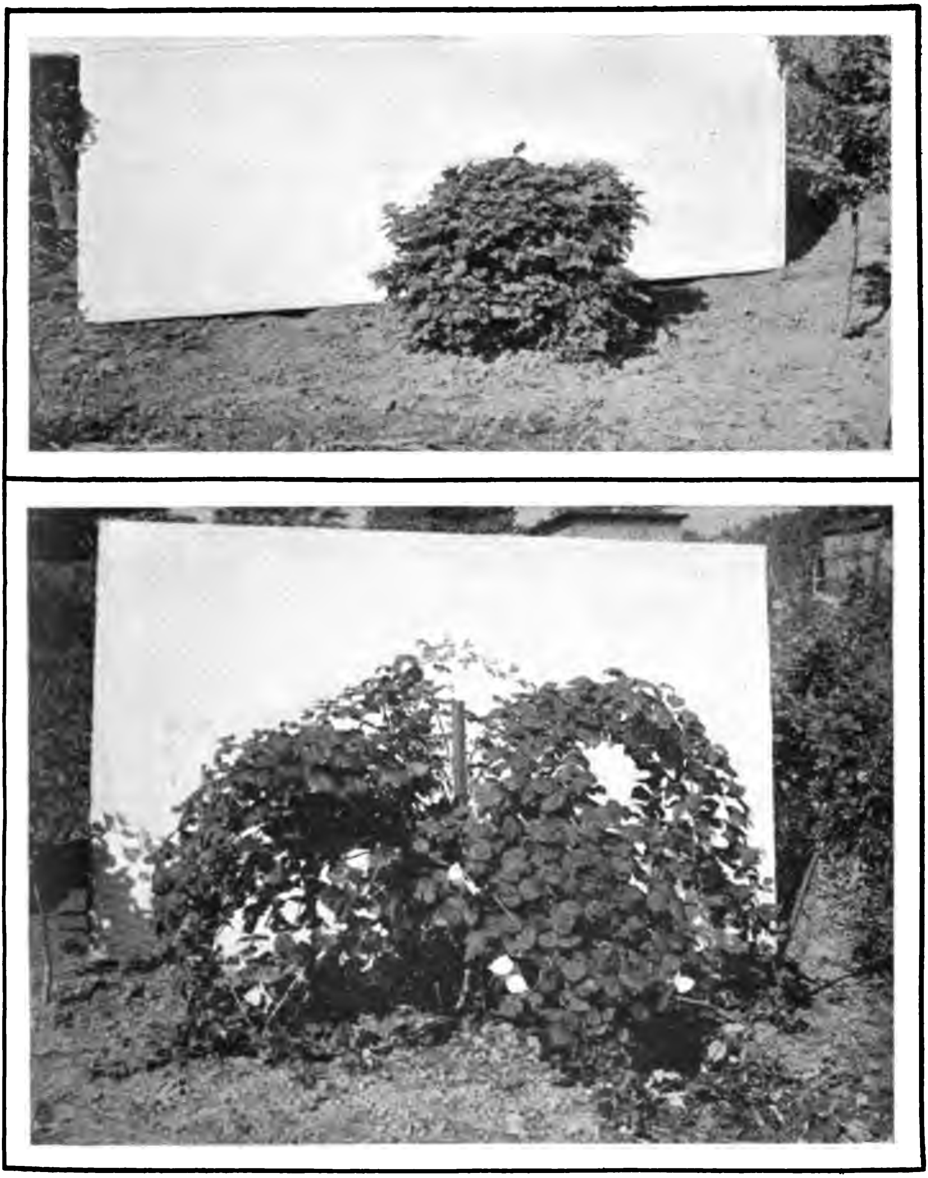

PLATE LXXIII.— ONE OF TALLEST DWARFS COMPARED WITH A STANDARD PLANT OF SAME PARENTAGE.

PLATE LXXIV.— *Rubus strigosus* × *Rubus odoratus.*

Herbert.— In 1913 fifty-five pure seedlings of Herbert were placed in the test plantation. Many of these lacked vigor and the following summer 25 were dead. Most of the remainder fruited in 1915. The plants as a whole were low-growing and all but a few were lacking in vigor. On the other hand those plants which fruited had unusually large, conical berries. Some of these were too soft but a few were excellent. One yellow seedling was found.

Since only 7 per ct. of these pure seedlings were saved for further testing, it would seem that Herbert should be combined with some vigorous variety which needs larger size. The most promising red raspberry seedling now on the Station grounds was secured by crossing June with Herbert.

Cumberland. — This variety has been used in crossing both with other black-caps and with the June red raspberry. Excluding those which possessed any of the Smith No. 1 blood nearly seven hundred seedlings of the first type have been grown, and of these only 7 per ct. were worthy of a second test; while the seedlings of Cumberland and Smith No. 1 gave 19 per ct. for further propagation. Although the hybrid seedlings were better than the straight black-caps, they were much poorer than other hybrids without Cumberland blood.

Crosses of Cumberland with the Palmer and Hilborn black-caps and with June have given yellow seedlings.

Under a later heading will be discussed the appearance of a dwarf type among the Cumberland hybrid seedlings.

Smith No. 1.— This variety was sent to the Station for test in 1908 as a chance seedling of unknown origin. In 1909 and 1910 it was one of the best and most productive black-caps on the grounds and for that reason it was used in the breeding work. During the following years the plants were severely injured by unusually dry summers and the destruction of most of the bushes was completed by an attack of anthracnose. So far its seedlings have not seemed noticeably susceptible to either summer drought or anthracnose.

One of the most interesting points in the work of the last five years has been the high proportion of promising seedlings secured from this variety. Out of more than five hundred pure seedlings 23 per ct. were retained for a second test. More than a thousand seedlings were obtained by crossing with other black-caps and of these 30 per ct. were saved while seedlings of Cumberland and of Hilborn gave 7 and 4 per ct. respectively. Among the hybrid purples 24 per

ct. of the Smith No. 1 seedlings were retained while only 12 per ct. of the Cumberland seedlings escaped the brush pile.

Many of the Smith No. 1 seedlings bred in 1910 and retained for more extensive testing fruited a second time in 1915. All who have had the pleasure of studying these are agreed that they are a most remarkable lot because of their production, size, fine appearance, firmness and good quality.

All of the hybrid seedlings of this blood — over six hundred — are purple and among the 1400 black-cap seedlings all but two were black. Among the large number of crosses involved, it is entirely possible that these two were foreign plants which became mixed with the Smith No. 1 seedlings. If this is the case, we must consider this variety as homozygous for the black color factor.

The pure seedlings which fruited first in 1915 were very uniform both in bush and fruit characters. They made a vigorous growth and had stocky, dark reddish-purple canes well covered with bloom and plentifully supplied with stout spines of medium length. The fruit was large, firm and inclined to be somewhat conic on many bushes.

INHERITANCE OF COLOR OF FRUIT.

Black-caps.— It is very evident that several of our black raspberries are heterozygous for color. Yellow-fruited seedlings have been secured from Cumberland, Hilborn and Palmer but in such small numbers as to indicate several pairs of color characters. From the evidence at hand it would seem that Smith No. 1 is a pure black.

Red raspberries.— Cuthbert, Herbert, Marlboro and June have given yellow seedlings. The following is the result for those crosses of which we have complete records.

Cross	Seedlings	
June x Cuthbert	60 red	2 yellow
Marlboro x June	66 red	4 yellow
Herbert selfed	55 red	1 yellow
Total	181 red	7 yellow
Ratio 26:1		

There may be either two or three color factors involved here.

Purple raspberries.— The selfed seedlings of Columbian would indicate a partial coupling of the red and black color factors. According to Wellington there were 31 purples, 7 " red wine," 2 doubtful

plants red, 1 yellow and 1 black. The "red wine" plants evidently possessed a color factor other than red which resulted in somewhat darker fruits, and as the reds turned purple when fully ripe they probably contained a black factor. Since Columbian is supposed to be a seedling of Cuthbert, the yellow is not unexpected. With the present meager information an explanation of the black cannot be attempted.

From the first generation hybrid seedlings it would appear that a black-cap which is pure for color will produce only purples when crossed with a red, even when the latter contains a factor for yellow.

The cross, Cumberland by June, was evidently a combination of two plants both heterozygous for color. As a result, we have 165 purples, 7 yellows with a bush type approaching the red raspberry and one which might be described as a yellow black-cap. If these two types of yellows are due to different color factors, our problem is much complicated, but if they are the same we would seem to have a relatively small number of color factors involved.

INHERITANCE OF CERTAIN CANE CHARACTERS.

Glaucousness.— Among the purple seedlings there was a considerable number without the bloom which is found on so many black-caps and to a more limited extent on some of the reds. Columbian, which has glaucous canes, gave the two types in very nearly the ratio of three glaucous to one non-glaucous. The F_1 hybrids from Cumberland by June and Smith No. 1 by June also approached reasonably close to a 3 to 1 ratio. Evidently the non-glaucous cane is a recessive character.

Rough and smooth bark.— Many red raspberries have the bark roughened by the exfoliation of some of the outer bark. This is much less noticeable among the black-caps. The F_1 hybrid seedlings were studied for this character and it was found that, though Cumberland and Smith No. 1 had smooth bark and June less exfoliation than most reds, the seedlings could be separated in the ratio of three with rough bark to one smooth.

Spines.— Wellington found that among the Columbian seedlings there were 16 very spiny, 25 intermediate and 9 with very few spines.

A study of the F_1 purples shows the following:

	RATIO			
	Numerous	Few	Very few	None
Cumberland (many slight spines) x June (none, or only at base)	1.5	3	1.5	1
Smith No. 1 (numerous strong spines) x June (none, or only at base)	3	1.5	1.5	1

Probably there are several factors which determine the number of spines. Evidently Smith No. 1 transmits a stronger tendency to produce spines than does Cumberland. This tendency appears also in the pure seedlings of this variety.

ABNORMAL DEVELOPMENT OF FLOWER CLUSTERS.

Among the pure seedlings of Columbian three plants developed some unusual abnormalities.* In one the sepals varied in number from the normal five to very numerous and were arranged in single, double or sometimes triple rows. At the same time many berries were entirely sterile, many others imperfect, while several were perfect. Terminal blossoms usually showed greater modifications than the laterals. One case noted on this bush could be described in two ways: Either a terminal blossom elongated and the drupelets were replaced by small, sepal-like leaves from the axis of seven of which appeared leafy blossoms borne on pedicels a half-inch or less in length and producing from a few to several drupelets and at the apex of the elongated flower was a sessile, leafy, abortive blossom; or, the terminal stem was fasciated, the ordinary leaves were reduced to sepals and the eight blossoms just mentioned sprang from an exceptionally short length of stem. That the first view is the more probable is indicated by the fact that the base of the cluster was surrounded by eight sepals all in the same plane. Immediately below this calyx ring three small leaves were present. In the axils of the sepals taking the place of the drupelets, except those bearing the blossoms, there was a short, green, filament-like organ usually terminated with a dried up, thread-like tissue appearing like a dried style or filament. Sometimes this organ appeared like a further reduced sepal. The fruit of this plant was purple and those berries which were perfect were medium in size.

* These plants fruited in 1913 and were described by Wellington. Much of this description is taken directly from his notes.

Another plant was more abnormal than the above, all of the terminal blossoms showing a marked reversion to the leafy type. More of these secondary sepals bore blossoms in their axes — twelve and thirteen being found on two clusters — and almost all of these were sterile, though sometimes from one to six drupelets were formed. Surrounding the base of these modified blossoms were two rows of sepals. This bush was practically sterile, only one fruit with four purple drupes reaching maturity.

On a third bush many blossoms were entirely sterile while the terminal flowers of all the axillary flower clusters produced nearly perfect fruits. The main terminals were surrounded by two rows of sepals. One of the modified blossoms contained 20 secondary blossoms, each borne in the axil of a sepal-like leaf, and at the apex was one more bud; also there were three sepal-like petals with aborted buds. One berry that was picked to pieces possessed 24 drupelets. The fruit was yellow, small, and many were imperfect.

DWARF TYPES.

All the purple raspberries having Smith No. 1 as the female parent were standard plants but among the purples from Cumberland by June appeared some very interesting dwarfs.

These dwarf plants were easily distinguished from the normal ones, even when normal plants lacked vigor and made a low growth. There were nearly as many nodes on the dwarf canes as on the normal ones but the internodes of the former were much shorter, sometimes not even a quarter of an inch long. Many of the leaves were very small but a few were nearly normal. The attachment of the petiole was very brittle and the leaves snapped off easily. The canes were thickly covered with soft spines while most of the standards had but few stiff spines. Those dwarfs which were the most vigorous made a thick, bushy growth somewhat like the red raspberry yet they could not be said to form suckers. Many dwarfs were under a foot in height and the tallest were hardly two feet.

In the entire population there were 46 dwarfs and 178 standards. The dwarfing was accompanied by lack of vigor in most plants so that there was a higher percentage of mortality here than with the normal plants. Taking this into consideration, we see that this is reasonably close to a 1 to 3 ratio. Selfed seedlings of Cumberland have never been grown here but several years ago a number of June

seedlings were planted. An unusually dry summer destroyed the majority of them so that notes were not taken of individual plants and all not showing vigor were discarded. In this way no note was made of any dwarfs though they may have been present in considerable numbers. Pure seeds of June are now in the stratifying bed for next year's planting.

The factor for dwarfing is evidently one of rather rare occurrence as this is the first time it has been noticed among the Station seedlings.

A CORRELATION IN LEAF AND FRUIT COLOR AMONG RASPBERRIES.

Over one hundred and fifty red raspberry varieties and seedlings fruited on the Station grounds in 1915. In examining these it was found that on all plants the terminal leaves on the young canes had the upper surface more or less tinged with red. On some this tingeing extended down the cane for three or four leaves, on others only the first leaf would be colored. The gland-like tip of the leaf serrations on these young, expanding leaves was red or tinged with red as was also the tips of the leaf serrations on the older leaves farther down the cane.

Yellow raspberries have originated on the Station grounds in two ways: from crosses of red sorts and from crosses of the black-cap and red raspberry. In either case the opening leaves on the young shoots lack this reddish tinge noticeable on the red raspberry and the gland-like tips of the serrations of both the young and older leaves are a light greenish yellow.

Among the hybrid purples these leaf marks are not as clearly distinguishable. In some of the latter the young leaves lacked the reddish tinge on the upper surface though in some it was nearly as marked as in the red raspberries. All the purples which were examined, however, did have the glandular tips of the serrations of these young leaves tinged red although on some only the serrations nearest the apex showed this. The purples also showed a greater tendency for these markings to vary on different canes on the same plant. On the older leaves of all the purples the gland-like tip of the serrations was red and this was the most easily determined character to separate the yellows and the purples.

It would seem from the above that it is entirely possible to tell all yellow raspberry plants from either the red or the purple sorts by a

study of leaf coloration. Although this point has not been as carefully studied, it would also appear that, during the dormant period, the bark of the younger canes of the yellows is entirely lacking in any tinge of red or purple. Some purple raspberry bushes can be distinguished from red raspberries by the lesser amount of coloring on the upper surface of the young leaves but many have practically the same amount as the red raspberry.

AN INTERESTING HYBRID.

In the spring of 1913 the flowering raspberry, *Rubus odoratus*, was crossed with the red raspberry, the blackberry and the dewberry. Only a few seeds were secured from the dewberry crosses and the same was true of all other crosses where the flowering raspberry was the female. With the Herbert red raspberry and the Blowers blackberry a plentiful supply of seeds was secured. The Herbert seedlings made a strong growth and nearly one hundred were planted for fruiting but the Blowers seedlings were very lacking in vigor and although thirty small plants were set out all died before the beginning of the second season. The Herbert seedlings blossomed freely in 1915.

A study of these seedlings leaves no doubt as to their hybrid origin. The cane characters are clearly those of *R. odoratus* and the individual blossoms are scarcely distinguishable from those of this species; on the other hand, the leaves are palmate as in the red raspberry. The flower panicles were unusually large and bore a profusion of blossoms but many of these failed to set fruit and the others had but a few drupelets. As these plants blossomed at a time when no other raspberry flowers were open, they probably received no cross-pollination.

These hybrids are interesting because they suggest that *Rubus odoratus* may serve as a go-between through which we may mix the blood of several of our Rubus species.

In this connection it is worth while calling attention to the desirability of much more extended effort in producing hybrids not only among our cultivated species but also with the many wild ones, especially those which recent explorations have brought to us from Asia and South America and which possess so many new and striking characters. There are now growing on the Station's grounds nearly fifty species of Rubus. Many of these will be discarded but all those showing valuable characters will be intercrossed. The

proportion of viable seeds which can be secured in such crosses is very low and the chances of obtaining the desired combination of good qualities are very few. This is the fate of many of the plant breeder's dreams but the remarkable success of two raspberry hybrids, the Loganberry and the purple raspberry, would encourage even the pessimist to continue along these lines.

NEW OR NOTEWORTHY FRUITS. IV.*

U. P. HEDRICK.

INTRODUCTION.

Not infrequently one hears fruit growers deploring the multiplicity of varieties. Some thus set their faces against new fruits without rhyme or reason, but usually the man finding fault dismisses novelties with the curt and summary dictum "they don't pay." Happily, notwithstanding growing indifference, and some open opposition, to increasing the number of varieties, the divine curiosity that leads some men to invent leads others to breed fruits, so that, of the production of new sorts, like the making of books, there is no end. Do they pay? Should the influx of new varieties be encouraged or discouraged?

In the issue raised we believe that all interested in better fruits should welcome new varieties. Without them, broadly speaking, there can be no improvement. Old varieties have been changed little or not at all; nor can they be except, possibly, and very rarely, wholly depending on the whim of Nature, in such minor matters as a change of color in the skin of the apple, or loss of pubescence in the peach. No one of our fruits is yet perfect; and until perfection be attained, new varieties, better in one or more characters, be the improvement ever so small, are well worth their cost for the progress they make in the development of fruits.

If the multiplication of kinds helps to evolve more perfect fruits, what matter if many, even most, new fruits turn out to be unprofitable in dollars and cents? It must be so. Nature everywhere uses a lavish hand in improving life. The little time and expense needed to apply the test of fitness to a new fruit is a cheap price to pay for the development of better fruits. The purchase of a novelty which turns out badly is often a keen source of disappointment — the commonest cause of the hostile attitude toward all new varieties – but with the exit of the offending fruit, if new ventures be made,

* A reprint of Bulletin No. 414, January, 1916.

wisdom in purchase growing with experience, the trial grounds on a fruit farm cannot but be a source of pleasure and profit.

When fruit growers say new varieties "don't pay," they mean, of course, that there is no immediate profit. But often there is — to prove which numerous fruits introduced within the last few years might be named. It is not too much to say that, with one or two exceptions, all of the fruits grown in this climate have been improved during the past decade by the introduction of sorts that are earlier or later, higher in quality or handsomer, hardier or more productive, or that keep or ship better than the sorts whose places they are expected to fill. Now a new fruit that fulfills any of the conditions named better than the old varieties can hardly fail to be profitable in commercial plantations. No doubt many of these outlying varieties, sorts introduced to push forward fruit growing in one direction or another, have little or no commercial value, but just as a field can increase only at its borders, where weeds are most plentiful, so a fruit improves only by its frontier varieties, many of which may be little better than weeds.

Again, there is profit in growing many varieties for variety's sake. In the business of growing fruit a multitude of varieties is needed for a multitude of consumers. Dessert and culinary requirements are many and are not nearly met by the niggardly assortment which commercial fruit growers are now putting on the markets. Too close a specialization on Baldwins, Bartletts, Elbertas, Bradshaws, Montmorencies and Concords cannot but cut the total sales of New York fruits. A greater variety from which to choose would further the enjoyment and consumption of the fruits of the region by those who know them and would increase purchases among those who now buy little fruit or prefer an exotic product.

To be sure, a commercial fruit grower must make haste slowly in planting new varieties. He must demonstrate its value, or have it demonstrated for him, before setting out an orchard to a novelty. If his taste so inclines, a fruit grower should have a fruiticetum, or tree garden, in which to put promising new fruits on probation. While few fruit growers can afford to grow all of the new varieties which the catalogs illustrate by word and picture as "faultless," yet, again we say, it is good business, almost a duty, for orchardists to try some of the novelties offered.

But it is certain that neither time nor money suffice for the fruit

PERFECT

grower to determine for himself the merits of all of the new fruits. In New York the State Experiment Station attempts to do this for him, and from year to year a bulletin is published to show what fruits on the Station grounds, either novelties or old sorts now neglected, are sufficiently noteworthy to deserve the attention of fruit growers. This is the fourth such publication.

The number of fruits competing in the test with those we have included in the report for this year are as follows:

The named varieties include:

Apples,	421	Apricots,	48	Black raspberries,	23
Pears,	187	Nectarines,	34	Purple raspberries,	5
Quinces,	18	Gooseberries,	83	Yellow raspberries,	1
Plums,	322	Currants,	35	Dewberries,	9
Cherries,	109	Blackberries,	42	Grapes,	411
Peaches,	377	Red raspberries,	32	Strawberries,	44

Of distinct species there are on the Station grounds:

Pyrus,	50	Juglans,	3
Prunus,	38	Corylus,	3
Rubus,	61	Castanea,	2
Ribes,	25	Sambucus,	4
Vitis,	16	Fragaria,	3

APPLE.

Perfect is an improvement over Baldwin. At least it is a better keeper, and this difference, other characters being equally good in the two varieties, makes Perfect the better apple. At this Station, for three seasons Perfect has been a month later in coming to edible condition and has remained in season a month to six weeks longer. Baldwin in some parts of New York is an early winter apple, as it is in southern and western states; Perfect, in such regions, becomes a finished product a month later and can be left for a turn in the market when Baldwin might have to be sacrificed.

The other differences between the two varieties, so far as we know them, are unimportant. The apples of the two sorts are of the same size; Perfect is not quite as bright in color, bearing somewhat the aspect of Winesap in both color and shape; the flesh of Baldwin is a little yellower, with the texture and flavor of the two sorts identical. The shape of the young trees is the same, but in

32

color of wood Perfect is darker and the lenticels are neither as large nor as conspicuous as on the wood of Baldwin. As to whether the new variety is as uniformly productive and vigorous as Baldwin remains to be seen; the behavior of the young trees indicates that there will be little difference between the two sorts in characters of growth and yield.

It is safe to say that Perfect is a seedling of Baldwin. It was found in a fence corner on a farm owned by W. F. Cobb, South Turner, Maine, some years ago. The long-keeping qualities of the fruit attracted the owner and the variety was sparingly propagated, after which the product was in demand for foreign shipment. Rice Brothers Nursery Company, Geneva, New York, purchased the entire stock in 1904, and are introducing the variety.

Tree vigorous, hardy, healthy, productive; branches strong, upright-spreading, forming a rather round, dense top. Fruit large, roundish-conic, somewhat ribbed, uniform; stem medium in length, thick; cavity acute, moderately deep, broad, often russeted, sometimes furrowed and occasionally lipped; calyx large, closed; basin medium in depth and width, rather abrupt, furrowed; skin moderately thick, smooth, dull, oily; color dull greenish-yellow, considerably overspread with dark, dull green which is almost solid on well-colored specimens but becomes mottled as the color fades, indistinctly splashed with carmine; flesh yellow, firm, somewhat coarse, crisp, moderately tender, juicy, subacid, good; season January to May.

PEACH.

Rochester.— New York fruit growers have long desired an early yellow freestone peach with suitable tree-characters for a commercial plantation. In previous numbers of "New and Noteworthy Fruits" we have described two varieties, Edgemont and Niagara, as possible candidates for the place of " best early " in the seasonal procession of yellow, freestone peaches. We herewith present a third peach for this important place in the fruit list of the State. The latest competitor is Rochester, like both Edgemont and Niagara a member of the Crawford group and in several respects a marked improvement on the well-known Early Crawford.

Rochester, in season, regarding the crop as a whole, certainly precedes Early Crawford several days, ripening soon after the middle of August. The introducers say that it is two weeks earlier, a statement made possible by the fact that its season is very long, a few specimens ripening extremely early. The great length of season of this variety under some circumstances may be an asset, under others a liability, to the peach grower. As the color plate shows,

ROCHESTER

REINE HORTENSE

the peaches are large, yellow, with a handsome over-color of mottled red, more rotund than either of the two Crawfords or Elberta, making, all in all, a strikingly beautiful peach. The flesh, too, meets all the requirements of a good peach — thick and firm, marbled yellow, tinted with red at the pit, juicy, rich, sweet and in all respects fully up to the high standard of palatability found in peaches of the Crawford group. While the variety must be classed as a freestone, yet there is a slight clinging which may disappear under some conditions and may be augmented under others. Rochester seems to be sufficiently productive for a good commercial fruit but it remains to be seen how generally it is adapted to soils and climates. Should its range of adaptability be great, Rochester, by virtue of earliness, good quality and handsome appearance, at once takes a high place in commercial peach growing in New York.

Rochester came from a seed planted about 1900 on a farm owned by a Mr. Wallen, near Rochester, New York. It was introduced by the Heberle Brothers Nurseries, Brighton, New York, in 1912.

Tree upright, slightly spreading, productive; branches stocky, reddish-brown, covered with ash-gray; leaves six inches long, one and five-eighths inches wide, oval to lanceolate accuminate, lighter green than Elberta, nearly smooth. Fruit matures late in August; rounder than Elberta but as large, slightly oblate, somewhat compressed; halves unequal; cavity deep, wide, flaring; suture shallow, deepening near the apex; apex roundish with a variable tip, usually mucronate; color lemon-yellow becoming orange-yellow, mottled with red, often merging into a flush of deep, dark red; splashes few; pubescence heavy; skin rather thick, tough, free when fully ripe; flesh yellow, tinged red at the pit, very juicy; very good in quality; stone nearly free.

CHERRY.

Cherry growing has run to commercialism in the United States until now it is impossible to buy the fruit of more than three or four of the hundred or more Sour Cherries in the markets or of more than a half dozen sweet sorts out of a score of Sweet Cherries that might be furnished in any part of the country. Meanwhile the Dukes, hybrids between the sweet and the sour species, have practically disappeared from the markets and fruit lovers have lost one of the most refreshing and delectable of our dessert fruits. Fortunately most of the Duke cherries are hardy, vigorous and adapted to many soils, making it possible, in New York, at least, for all who have a garden or even a backyard or fence corner to have one or a few trees of these cherries. Of the many splendid cherries of this group, Reine Hortense is as good as any and better than most.

Reine Hortense.— Several qualities fit Reine Hortense admirably for home plantations. To begin with, the trees are only medium in size, almost dwarf, and take but little room or can be trained, as is often done in Europe, on walls or buildings. The cherries are excellent in quality, the flavor being a commingling of the refreshing acidity of the Sour Cherry and the richness of the Sweet. The fruits, too, are handsome — large, round, bright, glossy red, very uniform in shape, size and color. To add to the desirability of the variety for home planting, the trees are very attractive in leaf, flower and fruit, especially in fruit, the cherries hanging in twos and threes thickly scattered and never much clustered. The cherries hang long on the trees but are too soft for distant shipment.

Reine Hortense is an old French sort introduced and widely grown in America in the middle of the Nineteenth Century when amateur fruit growing was at its height and high quality took precedence over all other characters.

Tree of medium size, upright-spreading, productive; branches smooth, dark reddish-brown with a few large lenticels; leaves large, oval to obovate, thin; blooming season short, intermediate in time; flowers large, one and one-fourth inches across, borne usually in threes. Fruit matures in mid-season; nearly one inch in diameter, oblong-conic to obtuse-conic, compressed; cavity somewhat shallow, often lipped; color amber-red; stem tortuous, slender, long, adherent to the pulp; flesh pale yellow, with colorless juice, tender and melting, sprightly subacid; of very good quality; stone free, rather large, oblong to oval.

GRAPE.

Niagara has long been the leading green grape in New York, a position it attained, in large part at least, through having been well advertised. It is deservedly popular, however, but there are other green grapes competing with it, now quite eclipsed by Niagara's reputation, that should receive more general recognition by both commercial and amateur grape growers. One of these is Empire State, old, and once well known, but now quite too generally neglected.

Empire State, compared with Niagara, is as vigorous, as free from insects and fungi, as productive, and is but little, if any, less hardy, though both sorts fall short in this respect. In two characters, Empire State quite surpasses Niagara. It is far better in quality and may be kept longer. In quality Empire State ranks among the best of the native grapes, approaching in flavor any of the good Old World sorts, its delicate wild taste suggesting the muskiness

EMPIRE STATE

HERBERT

of the European Muscats rather than the foxiness of native grapes. The variety ripens a little later than Niagara and keeps much longer, retaining its fine flavor until the last. In one important respect Empire State cannot compete with Niagara — the grapes are not nearly as handsome in either bunch or berry.

Its several excellencies, as compared with grapes of its kind, should give it a welcome place in the gardens and vineyards of New York, but there is an added reason for the cultivation of Empire State. It is distinctly different in its horticultural and botanical characters, being a combination of the wild Riparia and Labrusca of American woods and the Vinifera of the Old World and thus adds a new and brisk flavor to our dessert grapes.

The variety is one of several remarkable sorts from James H. Ricketts, Newburgh, New York, having fruited first in 1879.

Vine usually vigorous, in some locations tender, productive, canes short, few, slender, brownish, not flattened at the slightly enlarged nodes; leaves rather small; upper surface light green, glossy; lower surface tinged with bronze, heavily pubescent; flowers fertile, open late. Fruit somewhat variable in season of ripening, averaging a few days later than Niagara; ships and keeps well; clusters medium to large, long, slender, cylindrical to tapering, frequently single-shouldered. Berries variable in size, roundish, pale yellowish-green, covered with gray bloom, persistent; skin rather thick, adherent but slightly to the pulp; flesh pale yellowish-green, translucent, very juicy, tender, sweet next the skin but somewhat acid at the center, pleasant flavored; good to very good; seeds adhering slightly to the pulp, small.

RASPBERRY.

Herbert.— It is twenty-five years since the Herbert red raspberry came to light and it has been grown more or less in New York for ten years, yet in this time it has not attained the popularity it deserves. Herbert, as comparisons to be made later will show, is one of the best berries of its kind, yet many large berry growers have not tried it and few of the nurserymen list it. In a collection of thirty-two sorts, Herbert is, after June and Marldon, the most valuable red raspberry on the Station grounds.

The preeminent merits of Herbert are: Great vigor and hardiness, being rather hardier than the well-known Cuthbert; comparatively few suckers; and, most valuable of all, tremendous productivity, being nearly twice as productive as the old standard, Cuthbert. The season is about that of Cuthbert but usually continues a few days longer. The berries are somewhat similar to Cuthbert but are more sprightly in flavor, a little larger, rounder and, unfortu-

nately, a little softer. The fact that the fruits will not hold their shape quite as well as some other sorts is the chief and about the only point of inferiority in the variety. The berries, however, are firm enough to carry to nearby market with ordinary care.

Herbert is a chance seedling found in the garden of R. B. Whyte, of Ottawa, Canada, about 1891. The variety was introduced in 1904 by The Renfrew Nurseries, of Renfrew, Canada.

Plants vigorous but not so tall as Cuthbert, upright except when borne down by the weight of fruit, hardy, healthy, very productive; canes intermediate in size and smoothness, numerous, dull red; prickles medium in length and number. Leaves oblong-oval, dark green, rugose. Flowers large; petals rather large, oval, tapering to short, abrupt claws. Fruit matures late, about with Cuthbert; large to very large, broadly ovate, with medium to large, coherent drupes, dark red, juicy, somewhat soft under unfavorable conditions, pleasant flavored, sprightly; good in quality.

NEW OR NOTEWORTHY FRUITS. V.*

U. P. HEDRICK.

INTRODUCTION.

This is the fifth bulletin published by the New York Agricultural Experiment Station on new or noteworthy fruits. In these bulletins the best recent fruit-introductions grown on the Station grounds are described and their prominent pomological merits set forth. Occasionally an old variety is considered. The old sorts brought to new light are varieties which, for one reason or another, have been all but lost, or such as suffer from neglect, or kinds which under old methods of culture were defective or unmanageable but under modern care prove tractable and profitable. These are the "noteworthies" of the title.

Fruit-growers have written that they were disappointed in varieties described in the publications on new and noteworthy fruits from this Station. This is to be expected. There is no all-round variety of any fruit. No sort grows equally well in all soils and climates and serves all purposes. A variety is a combination of characters and these change in their relationships to each other with every change in conditions. A sort that succeeds in one place fails in another. A description of a variety made on the Station grounds may not fit the fruit in all particulars as it grows a few miles away. This Station, then, cannot select varieties to suit soils and climates in other parts of the State. Varieties must be tested for every locality, for every commercial demand and, more or less, by every fruit-grower.

What purpose, then, do the tests of fruits on the Station ground serve? First, by testing many varieties side by side we can make certain whether each is distinct. Second, we can tell the relative time of blooming, leafing, ripening and of plant-maturity. Third, precocity or tardiness in coming in bearing may be ascertained. Fourth, susceptibility to insect and fungus pests may be measured, to some extent. Fifth, we can ascertain for what purpose varieties are best adapted — whether for dessert, culinary purposes,

* A reprint of Bulletin No. 427, December, 1916.

canning, evaporating, local market, general market and so on. Sixth, varieties may be described so that they may be identified by those mentally equipped to interpret descriptions. Seventh, it can be told that a variety succeeds, in comparison with standard sorts, on the soil, under the climate and with the exposure given it on the Station grounds and that it enjoys the particular treatment given. Every one of these results of variety testing is of permanent value to fruit-growers.

Testing a variety on the Station grounds, however, cannot determine its full range of adaptability. Indeed, we often find that a variety succeeds on one part of the Station farm and fails on another. Station tests cannot possibly tell under what conditions a variety will succeed or fail. The fruit-grower, we repeat, must find out for himself whether a variety is adapted to his farm. The ability to discover what varieties best suit his soil, climate and other conditions is a chief requisite to success in a fruit-grower. Of course, when a great number of fruit-growers agree that a variety is valuable for a type of soil or for a purpose for which it is grown, we have about the best criterion of the value of the variety.

Many fruit-growers believe that varieties change for better or worse. They hold, on the one hand, that a variety may become adapted to a condition to which it was not at first suited; on the other hand, that under some conditions varieties slowly but surely degenerate. The notion is not new. Indeed, no one has better expressed it than the prophet Jeremiah some thousands of years ago. Jeremiah laments:[1] "Yet I had planted thee a noble vine, wholly a right seed: how then art thou turned into the degenerate plant of a strange vine unto me"? Jeremiah's question remained unanswered and the centuries since his time have brought forth so little evidence to show that fruit-varieties change that the theory is not now in good repute in science. The weight of scientific authority is against the notion that varieties propagated by cuttings, grafts, buds or other such parts either improve or degenerate. Science very generally accepts the belief that "in vegetative reproduction, heredity is complete." Fruit-growers, we believe, may expect a variety to behave just as did the plant of origin. The descriptions of varieties of fruit made today will fit for all time if the variety is grown under the same conditions.

[1] *Jeremiah* II:21.

J. H. HALE

The number of fruits growing on the Station grounds competing with the varieties described here, are:

Apples	368	Apricots	40	Black raspberries	23
Pears	175	Nectarines	33	Purple raspberries	5
Quinces	19	Gooseberries	74	Yellow raspberries	1
Plums	279	Currants	35	Dewberries	8
Cherries	110	Blackberries	40	Grapes	390
Peaches	373	Red raspberries	29	Strawberries	69

Of distinct species there are on the Station grounds:

Pyrus	38	Juglans	5
Prunus	30	Corylus	3
Rubus	53	Castanea	2
Ribes	25	Sambucus	4
Vitis	16	Fragaria	1

PEACHES.

J. H. Hale.— For the past few years the J. H. Hale has been the sensation of the pomological world having, beside many merits to commend it, the name and fame of the originator and of the introducers to bring it to the attention of fruit-growers. It is much like Elberta, compared with which it is larger in size and rounder in shape. Possibly the J. H. Hale is a trifle too large when the trees are at their best. In shape the fruits are almost perfect spheres, being much more attractive in this character than the oblong Elberta; and they can, too, because of their rotundity, be packed to better advantage. The symmetry of the peach is scarcely marred by the suture. In color there is no choice between Elberta and J. H. Hale — both are voluptuously handsome. The skin of the J. H. Hale is less pubescent and is possibly a little firmer and tighter which, with greater firmness in flesh, will probably enable growers to ship it farther and keep it longer than they can Elberta. In all the characters that go to make up quality,— as color, aroma, texture and juiciness, there is little choice between the two, neither, in comparison with many other peaches, ranking as extra good.

The variety has not been grown long enough in the State so that we can be certain of the merits of the tree. The consensus of opinion wherever growers have tried the two side by side is that J. H. Hale is a little hardier in both wood and buds than Elberta.

J. H. Hale ripens its crop a few days earlier than Elberta although in the markets the fruits of the two varieties will probably compete. Which is the more productive in New York cannot be determined from the data at hand nor shall we know until a large number of growers report as to the productiveness of the two in the diverse soils of the State. In the past Elberta has been the cosmopolite among peaches, adapting itself to a greater diversity of soils, exposures and climates than almost any other variety; it remains to be seen whether J. H. Hale is equally adaptable to the varied conditions of the State. The variety is still on probation in New York but each year sees it more and more planted and we shall expect it shortly to be numbered among the best commercial peaches of this region.

The variety came from a chance seedling found by J. H. Hale, South Glastonbury, Connecticut. From its characters one sees at once that it is either an offspring or is very closely related to Elberta. Mr. Hale tested the variety in commercial orchards in Connecticut and Georgia and then sold it to the William P. Stark Nurseries, Stark City, Missouri, for introduction. Distribution began in 1912 and has been rapidly carried on during the past four years.

Tree vigorous, upright-spreading, productive; branches smooth, ash-gray overspread with dark reddish-brown; leaves large, lanceolate, thin, dark green; flowers appear in mid-season. Fruit matures in mid-season; large, regular, round, with equal halves; cavity deep, wide; suture a mere line or very shallow; apex roundish, with a small tip set in a depression; color lemon-yellow overspread with attractive dark red and with mottlings and splashes of carmine; pubescence light; skin thick, tough, separates but poorly from the pulp; flesh yellow, red around the pit, juicy, fine-grained, sweet or somewhat sprightly; good in quality; stone free.

Pearson.— In spite of the fact that there are already many mid-season, white-fleshed peaches, Pearson, a newcomer, is well worthy the attention of New York fruit-growers. As the accompanying illustration shows, the fruits are large and handsomely colored, while almost perfect rotundity adds to appearance and makes them very suitable for packing. In quality Pearson is similar to the well-known Champion, about the best of all white-fleshed peaches, though possibly not quite so well flavored. It is, however, even freer of stone and ripens ten days earlier than Champion. The trees as they grow on the Station grounds are satisfactory in nearly every particular — vigorous, hardy, productive and healthy. We have no precise data as to its susceptibility to brown-rot and leaf-

PEARSON

DRAP D'OR

curl but so far it seems as free from these troubles as any other white-fleshed peach of its season. Pearson would probably have to compete with Mamie Ross where that variety is grown but is in most particulars a much better peach. We heartily recommend it both for commercial and home plantings.

This variety originated with J. M. Pearson, McKinney, Texas. Its parentage is unknown. It was introduced by E. W. Kirkpatrick of McKinney who thinks it may be a seedling of Chinese Cling.

Tree large, vigorous, spreading, the lower branches drooping, very productive; branches stocky, reddish-brown mingled with light ash-gray; leaves very large, oval to obovate-lanceolate, leathery, dull, dark green, smooth, becoming rugose along the midrib; flower-buds hardy, long, heavily pubescent, plump; blossoms appear very early, nearly two inches across, pink. Fruit matures in early mid-season; large, round-oval or somewhat cordate, compressed, with unequal halves, bulged near the apex; cavity medium to deep, with tender skin; suture variable in depth; apex round or depressed, with a small, mucronate or recurved, mamelon tip; color greenish-white with a blush covering much of the surface, more or less mottled; pubescence thin, fine, short; skin thin, tough, semi-free; flesh white, faintly tinged with red near the pit, juicy, stringy, tender and melting, pleasantly flavored; good in quality; stone semi-clinging or free.

MIRABELLE PLUMS.

To American fruit-growers, Mirabelle plums are best described as golden-yellow, sweet-flavored Damsons. These Mirabelles are hardly known in America but there are a dozen or more distinct varieties in Europe where they are highly esteemed as dessert fruits and for canning, preserves, compotes, prunes and tarts. This type of plum is represented by four varieties on the Station grounds — **Drap d'Or, Reine Mirabelle, Late Mirabelle** and **Mirabelle** — all of which are worthy the attention of fruit-growers. The small, round, yellow fruits are attractive in appearance and the sweet, pleasant flavor, whether eaten out of hand or however prepared in the kitchen, commend any of the four sorts to those who appreciate choice fruits. The trees are small but vigorous, hardy and healthy and thrive wherever Damsons grow — indeed they are so hardy and healthy that they are commonly used in the Old World as a dwarfing stock for other plums. French writers say that these Mirabelle plums come nearly true to seed and that peasants establish their small plantations by planting seed. The accompanying description and illustration are of Drap d'Or, one of the good Mirabelles though it is no better than the others of the type on the Station grounds.

Drap d'Or is an old European variety cultivated for at least 250 years.

Tree small, upright-spreading, dense-topped, hardy, productive; branches smooth, with few small lenticels; leaves small, medium in thickness and color, pubescent; flowers less than one inch across, creamy-white, usually in pairs. Fruit matures in mid-season; small, round-oval, compressed, halves equal; color greenish-yellow changing to golden-yellow, somewhat mottled and blotched, occasionally with a faint bronze blush on the exposed cheek, overspread with thin bloom; stem slender, adhering well to the fruit; skin thin, separates readily from the pulp; flesh light golden-yellow, medium juicy, coarse, firm but tender, sweet, mild; of good quality; stone small, free, oval, flattened.

RASPBERRY.

Empire is one of the most promising new, red raspberries on the Station grounds, having hardiness, productiveness, vigor of bush, healthiness, and large, handsome, firm, well-flavored fruits as its chief assets. The canes need no winter-protection in this region; equal any other variety in productiveness; are unusually vigorous, reaching a height of six or eight feet; and this season, 1916, when anthracnose was everywhere rampant, even on red raspberries, showed but a trace of this disease on the Empire. A peculiarity of the canes is that in mid-summer they are purplish-red but become brown at the close of the season. The berries average larger than those of the well-known Cuthbert, and are about the same color as those of that variety; they ripen a little earlier and have a longer picking season. The fruits are mild, rich and sweet so that the variety may be ranked among the best in quality. The texture is firm and without doubt the berries will stand shipment well and may be kept long. With such an array of good characters, it seems certain that Empire must take high standing among commercial red raspberries.

Empire originated in 1904 with L. E. Wardell, Marlboro, New York. It was obtained by crossing Ruby with Coutant. It was introduced by its originator in the fall of 1916. Mr. Wardell was also the originator and disseminator of Marlboro and Ruby. The first hill of Empire, twelve years old, is still vigorous, healthy and productive.

Plants tall, vigorous, upright, with medium number of suckers, hardy, very productive; canes smooth except for the few scattering, short prickles, stocky, long; prickles medium in thickness, short, few, becoming more numerous towards the base; internodes medium to short; buds large, long, pointed, plump, free. Leaves large, wide, medium in length, thick, dark green, rugose. Flowers appear early. Fruit matures in early mid-season, clings well to the torus yet picks easily; large, uniform, retains its size well to the close of the season, regular in outline, roundish-conical; cavity deep, medium in width; apex roundish or tapering slightly; bloom slight; drupes small, numerous, with strong coherence; color medium to dark red, glossy; flesh juicy, firm, mild, high-flavored; very good in quality; seeds medium in size.

EMPIRE

GOOD LUCK

STRAWBERRY.

Good Luck ranks among the best late strawberries on the Station grounds. In 1916 it surpassed all other late varieties in yield and proved to be one of the best shippers. Indeed, the flesh is so firm that it is doubtful whether any other berry of any season will surpass it in standing transportation. Another outstanding good character is that the plants are about the least susceptible of any sort on the Station grounds to leaf-spot. The fruits, as the color-plate shows, are large and handsome, both of these characters running very uniform as does also the wedge-like shape. The quality is particularly good for those who like a sprightly strawberry having, besides sprightliness, a most distinctive flavor. Perhaps the fruit is a little too acid for dessert but canned or cooked it is hardly surpassed in flavor. The calyx, though a little too large and too leafy, is a beautiful green. The fruit at the point of calyx attachment is rather remarkable because of small, mammiform protuberances. A defect in the variety is that the apex colors slowly so that the fruit must be picked carefully to avoid green tips. Plants of Good Luck must not be set closely as they develop many runners.

Good Luck originated with Mr. Elwood Pedrick, Cumberland County, Maryland, in 1904. Its parentage is unknown. It was introduced by W. F. Allen, Salisbury, Maryland, in 1907.

Plants numerous, large, vigorous, healthy, very productive; leaves medium in size and thickness, with crenate margins; upper surface medium green, somewhat rugose, slightly pubescent; lower surface silvery-green; leaf-stalks long, intermediate in thickness and pubescence. Flowers semi-perfect to perfect, medium in season of bloom, one and three-sixteenths inches across; petals roundish, six to seven in number; stamens variable in number, short; pistils slightly tinged red at the tips; fruit-stems long, thick, semi-erect, branching. Fruit matures late; large, retains size well to close of season, distinctly wedge-shape, with some cockscombs in the first picking; calyx large, flat, leafy, attractive green, often surrounded at the base by small, fleshy protuberances; seeds both raised and sunken; apex a pointed wedge, inclined to green tips unless picked with care; color attractive, medium red; flesh well colored to the center, juicy, firm, sprightly — almost tart; good in quality.

CULTURE AND FORCING OF WITLOOF CHICORY.*

J. W. WELLINGTON,

UNDER THE DIRECTION OF

U. P. HEDRICK.

SUMMARY.

Witloof chicory is a salad plant little grown in America but of wide and extended use throughout Europe. It is an improved variety of the common chicory, *Cichorium intybus* Linn., a native of Europe but now found naturalized in many parts of this country and often a pernicious weed.

The chicories are often confused with the endives, *Cichorium endivia* Linn. They are closely related species but are distinct, the first being perennial, the latter generally annual, though sometimes biennial.

The culture of Witloof chicory has attained great importance and perfection in Belgium and France, from whence large quantities were imported to America previous to the war.

In the belief that this vegetable can be grown and forced profitably by American gardeners, this Station is conducting investigations relative to its production.

It has been found that plants may be easily grown from seed in our environment.

Roots having a crown diameter within the limits of one to two inches produced the greater number of marketable heads.

Sand proved to be a very satisfactory medium with which to cover the forcing roots, in that it is easily obtainable, blanches the leaves perfectly and promotes the formation of compact heads.

Temperatures averaging 56° and 61° F. were found satisfactory in producing a marketable crop. It is evident that a range of 50° to 60° F. is approximately the optimum.

* A reprint of Bulletin No. 418, March, 1916.

The harvest produced at the Station was acceptable in quality and appearance and is much superior to the foreign product in flavor and in freshness.

Culture of this chicory is so simple that it is evident that American gardeners are missing an opportunity in neglecting its cultivation.

INTRODUCTION.

Botanically, Witloof chicory belongs to the great Composite family and to the species *Cichorium intybus* Linn. In its wild state chicory is found along the roadsides and in the fields of Europe and has now become naturalized in this country and in many sections is a pernicious weed. Great confusion exists between this species and *Cichorium endivia* Linn., which embraces the common garden endives in their various forms. The two species are closely related but are distinct, the chicories being perennials while the endives are usually annuals, though sometimes biennials. The terms chicory and endive are frequently interchanged, our seed catalogs adding to the confusion by calling Witloof chicory, " French endive ". This last name, though incorrect, is almost the only one known in the markets.

Many old writers contend that chicory and endive are of common origin while others ascribe the habitat of chicory to Europe and that of endive to East India, China and Japan, asserting that endive was first introduced to Europe about 1550 A. D. Pliny, Columella and other early Roman authors describe a plant, seemingly identical to endive, grown in their time in Roman gardens and used as a potherb and salad. Another ancient writer states that endive was held in very high esteem by the old Egyptians. It seems apparent that chicory and endive have been cultivated by man since time immemorial, and it is safe to state that the origin of each is lost in antiquity.

CHICORY AND ENDIVE AND THEIR CULTURE.

VARIETIES OF CHICORY.

There are several distinct varieties of chicory. Five kinds were grown upon the Station[1] grounds at one time, Common, Improved Very Large Leaved, Long Rooted Brunswick, Large Rooted Brussels or Witloof and Large Rooted Magdeburg. The last three are all used for forcing and, being similar, are probably all used in producing

[1] N. Y. Agr. Exp. Sta. An. Rpt., 1884. p. 286.

Witloof. The Common, or Wild, is also used to a limited extent for this same purpose.

Wild chicory, or succory, has had an extended use as an adulterant and substitute for coffee. The roots are used for this purpose, being dried, roasted, and ground. The product resembles true coffee in appearance and somewhat in taste. Chicory has been in use in America for many years as a field crop and in this manner the plant has been distributed about the country and in many regions has become naturalized as an escape from cultivation. Chicory may often be seen along the roadsides and in untilled fields and in midsummer is especially distinguished by its tall spike of attractive sky-blue[2] flowers. Wild chicory has been used as a medicinal plant although usually classed as an aliment. It is used as a potherb as are dandelions and the root forced in winter yields both heads and loose leaves, the latter known in the markets as Barbe de Capucin. The heads are, however, inferior in size and shape to those produced from the improved varieties.

Witloof chicory is an improved horticultural variety differing from the wild form in having a much larger root and big, broad, smooth leaves. Its place of origin is ascribed to Brussels, Belgium, and in consequence is often called Brussels chicory. The name Witloof is more exact, as there are other improved forms grown in the vicinity of the Belgian capital.

In view of the fact that modern practices in chicory culture are less than a century old, it is not surprising that so few distinct varieties exist and that much confusion should have arisen concerning the botanical classification of the plant. For many years the Belgians monopolized the culture of chicory but gradually the French learned that they could produce an equally good product and now Witloof chicory is grown extensively in the neighborhood of Paris and other French cities. In America little has been done with the plant in a horticultural way although some roots are raised and a small amount of salable chicory produced, but in no measure equal to the demand. In 1913 Witloof chicory was quoted in the London markets at 4 to 8 cents per pound showing that the vegetable can be profitably grown and sold at a comparatively low figure. Previous to the war Witloof sold readily in American markets at 25 to 30 cents per pound retail, the small shipments now occasionally received

[2] Sometimes pink and very rarely white

wholesale at 50 cents per pound. The difference now existing between sale price and cost of production is remarkable.

VARIETIES OF ENDIVE.

There are a great many varieties of endive, *Cichorium endivia*. Fifteen were growing at one time on the Station[3] grounds. The present bulletin is not concerned directly with endive and mention is made of varieties only because one at least, Broad-leaved Batavian, is often used to produce a winter salad called Escarolle which is sometimes confused with chicory salads.

WINTER SALADS FROM CHICORY.

A very attractive salad is made from the blanched leaves of Witloof chicory. The leaves are, when offered for sale, in the shape of a compact head, and owe this appearance to the manner of forcing. Witloof may be produced from wild chicory or from the improved varieties of other name, but the best product is forced from the true Witloof variety.

Barbe de Capucin is made from the leafy portion forced from the roots of wild chicory and often from those of the improved varieties. It differs from Witloof in appearance only, being offered for sale in the shape of loose-leaved heads. This salad is obtained by forcing the roots in darkness but without cover of sand or loose dirt.

These salads have a flavor like that of mild dandelions, a trifle bitter but soon very pleasing to the taste. They may be served fresh like lettuces or cooked like other potherbs. The leaves are very tender and succulent and present a very delectable salad dish at a season of the year when fresh vegetables are almost unavailable.

FOREIGN METHODS OF CULTURE.

Witloof chicory production has attained great importance in the skilled hands of the Belgian and French gardeners. Therefore, it seems particularly advisable that a brief review of foreign methods of handling this crop should be given at this time. Free use has been made of Prof. Henri Chevalier's[4] article on Witloof and of

[3] N. Y. Agr. Exp. Sta. An. Rpt., 1884, p. 285.
[4] *Gard. Chron.* 53: 405, 406. 1913.

a Vilmorin-Andrieux et Cie.[5] pamphlet on chicory growing. It is worth noting that there were, in 1913, 7,136 acres devoted to growing Witloof chicory in the vicinity of Brussels, not counting the extensive acreage about other Belgian cities. The exports for 1912 of Witloof from the port of Antwerp to America were 26,000 pounds and this did not represent anywhere near the total exportation to America, as consignments were also shipped from London and French ports. Belgium supplied Witloof to Germany, Switzerland and other European nations in large amounts.

Three varieties of chicory are in use by European gardeners: (1) wild, or common, (2) Witloof, and (3) Brunswick. The seed is sown in the open ground in late May or June — too early sowing may result in premature flowering. Especial stress is laid by European writers on the desirability of having seed of improved varieties, with the statement that other seed predestines poor results. The seed is sown in rows 10 inches apart and the seedlings are later thinned to 10 inches in the row. Frequent tillage is given and any plants showing a tendency to flower are removed. About the end of October the roots are lifted and those not desired for immediate use are stored in pits and covered with leaves. Those for immediate use are trimmed to a length of 8 or 9 inches and placed upright in specially prepared trenches. Belgian gardeners often prepare hot beds in warm, dry cellars or make use of a hot-water-heated, portable frame for outdoor work. This frame is known as a " thermosiphon " and with it a constant temperature of 60° to 70° F. is obtainable. This outdoor method is said to excel in the production of heads of uniform size and quality. In either manner of forcing, the roots are set upright in rows about six inches apart and two to three inches apart in the row. The roots are carefully placed so that all the crowns are on approximately the same level. After planting, the beds are covered with eight or nine inches of specially dry and loose soil.

The French system is the same as the Belgian outdoor method except that instead of using hot water pipes and frames for heat, a depth of twenty to twenty-four inches of fresh horse manure is laid over the completed bed. With this method twelve to twenty days are required to produce marketable heads, or " chicons " as they are called abroad.

[5] Vilmorin-Andrieux et Cie., Paris. Circular.

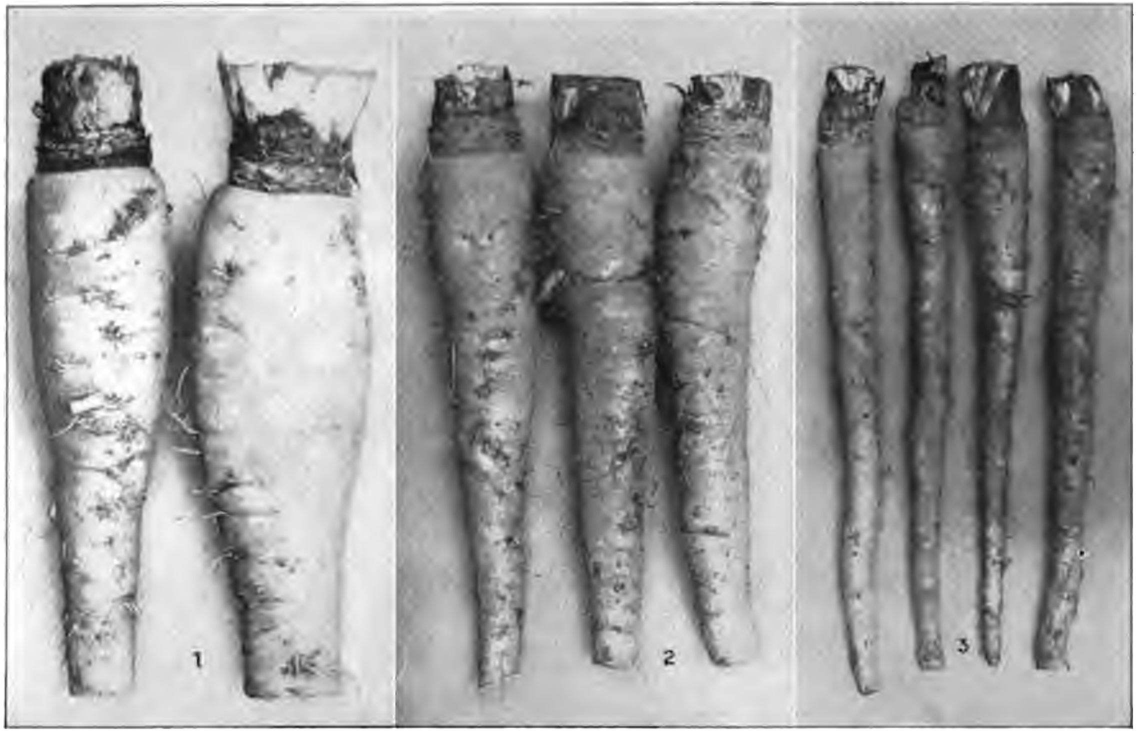

PLATE LXXV.— ROOTS OF WITLOOF CHICORY FOR FORCING.

1, "Extra" size,— too large, producing compound heads (Plate II, fig. 2); 2, "Large," size,— very satisfactory; 3, "Small" size, too small.

PLATE LXXVI.— WITLOOF CHICORY HEADS.

1, Heads from roots shown in Plate LXXV; left, too large; center, ideal; right, too small; 2, compound head; 3, forced roots, with crowns and heads.

PLATE LXXVII.— WITLOOF CHICORY AS MARKETED.
Upper, desirable heads; lower, heads packed in 3 lb. Climax basket.

When developed sufficiently — length four to six inches — the heads are cut from the roots, removing with the head a portion of the crown to keep the leaves together. The heads are cleansed of poor leaves, are washed and packed in basket hampers containing 10 kilograms (22 pounds).

STATION STUDIES ON WITLOOF CULTURE.

Interest in Witloof production at this Station has been of several years' duration and had its inception in the belief that this salad plant was well worthy of greater attention by American gardeners. It was evident that foreign methods of outdoor forcing would be of little value here in those months (December, January and February) during which this salad is in particular demand. Proper methods of forcing had to be established before a successful result could be anticipated. The cutting off of the foreign supply and consequent high prices has undoubtedly been the stimulus to carrying forward the work to an early conclusion. Preliminary trials in Witloof forcing proved one or two facts and showed also many points needing further study. It was found that a straw covering above the roots would not produce desirable heads while sand used for the same purpose yielded excellent results. It was seen that proper temperatures, suitable soils and covering materials, amount of water required during forcing, desirable size of roots and length of time necessary to produce a marketable crop were points all needing further investigation. In the preliminary work roots were purchased from a grower outside the State and it was thought advisable in the final work to grow roots on the Station grounds so that all phases of the culture might be under observation.

WORK OF 1915–1916.

Growing roots.— Seed of Witloof chicory was purchased in the early spring of 1915 from Sutton and Sons, Reading, England, it being desired to have as nearly as possible the same strain of seed as that grown abroad. The seed was sown about May 1st in the open ground in rows eighteen inches apart and later the plants were thinned to six inches in the row. Ordinary culture was given throughout the summer and since the plants made a peculiarly thrifty growth no special effort was devoted to their culture. They had the appearance of large, luxuriant, smooth-leaved dandelions. The roots

were lifted in November before freezing of the ground and the leaves trimmed away to within two inches of the crown. They were then packed in boxes and stored in a root cellar.

Forcing.— On January 3, 1916, the roots were brought from the cellar and graded into four lots, which for the purpose of distinction were termed Extra, Large, Medium, and Small. The number, average weight and size of roots in each lot, are shown in the following table:

TABLE I.— GRADATION OF ROOTS OF WITLOOF CHICORY USED IN FORCING.

SIZE.	Number used.	Average crown diameter.	Limits of crown diameter.	Average weight.*
		Ins.	*Ins.*	*Ozs.*
Extra	22	2	1.75-2.75	8.72
Large	34	1.39	1.19-1.75	4.83
Medium	52	.88	.75-1.10	2.00
Small	44	.64	.50- .75	1.07

* Trimmed and ready for forcing.

The plants have a very long main root and for convenience in handling it was necessary to trim the roots to a length of 8 or 9 inches. This shortening in no way interferes with the size or quality of the forced head as there is apparently a great excess of stored food. Some ungainly double and crooked roots were discarded on account of inadaptability to setting in the forcing soil.

In order to obtain two different temperatures during the forcing the roots were divided into two groups, each embracing roots of all the four lots. A large box was placed in each of two greenhouses ordinarily operated at quite different temperatures and one group was placed in each box. For sake of clearness the house having the higher temperature is designated as House 1, the house having the lower temperature as House 2 and boxes therein Box 1 and Box 2 respectively.

Unfortunately, as shown in Table II, the temperatures were not as widely separated as was anticipated. It will be seen that a variation of 5.2° in the mean temperatures of the two forcing soils was recorded. This was not sufficient to produce any marked difference in the respective harvests.

TABLE II.— TEMPERATURE OF SOIL AND AIR IN HOUSES WHEN FORCING WITLOOF CHICORY.

Box 1 (Higher Temperature).			Box 2 (Lower Temperature).		
Date.	Soil.	Air.	Date.	Soil.	Air.
January, 1916.	*Deg. F.*	*Deg. F.*	January, 1916.	*Deg. F.*	*Deg. F.*
3	Start	......	3	Start	......
4	48	59	4	51	47
5	52	53	5	50	49
6	56	61	6	49	46
7	60	63	7	57	48
8	63	58	8	55	46
9	61	60	9	56	53
10	61	56	10	54	55
11	68	67	11	60	54
12	72	67	12	60	50
13	72	63	13	59	55
14	66	58	14	58	47
15	64	58	15	56	54
16	60	46	16	58	52
17	58	42	17	60	56
18	60	55	18	60	52
Average	61.4	57.7	Average	56.2	50.9

The setting of the roots was accomplished by one man holding the root and packing the soil while another slowly shovelled. The soil used was old greenhouse material. Fertility is of no importance, as the roots do not draw on the soil for food, and any material that will pack closely about the roots and hold them in position should prove satisfactory. The crowns were all on the same approximate level. After setting, the soil was thoroughly watered and on the following day a covering of 8 inches of sand was placed over the bed. Standard soil thermometers were used in obtaining the temperatures and readings were taken at 8 A. M. It was noticed that the soil temperatures varied but little from night to day and did not change as rapidly as the surrounding air. The boxes were watered at regular intervals. Since the edible portion is largely water it is necessary to keep the soil moist during forcing. In a cellar it is evident that one good watering in the beginning might produce good results. At the end of the fourteenth day it was noticed that some leaves were protruding through the sand, showing that the crop was ready to harvest.

The effect of the somewhat higher temperature in Box 1 was evidenced in the smaller proportion of solid heads and in the tendency to shoot up too rapidly. Although the average of this box was only 61.4° F., there were days when it was too warm for best results. It was evident that a steady temperature of about 60° F. would be the optimum and that lower degrees would be satisfactory but would require more time to mature a crop.

TABLE III.— EFFECT OF DIFFERENT TEMPERATURES IN FORCING WITLOOF CHICORY.

SIZE OF ROOTS.	Number of roots.	Total weight of heads.		Average weight of heads.	Variation from average of both lots.	Percentage of marketable heads.
		Lbs.	*ozs.*	*Ozs.*		*Per ct.*
Box 1.— Average soil temperature 61.4° F.						
Extra	10	3	10	5.8	+.62	50
Large	21	4	11	3.57	+.17	67
Medium	18	1	14	1.66	+.10	67
Small	18	1	1	.94	+.01	33*
Box 2.— Average soil temperature 56.2° F.						
Extra	12	3	8	4.66	—.52	50
Large	33	6	13	3.30	—.10	76
Medium	34	3	3	1.50	—.06	76
Small	26	1	8	.92	—.01	46*

* Really too small to be correctly classed as marketable.

The size of head was in accordance with the size of root used. The Extra size produced many ungainly, compound heads consisting of many small divisions, edible but not attractive for market. There were many good shaped heads produced from the "Extra" roots but these however were generally too large for best market uses, being above the size desirable for individual portions in the restaurants and cafes. These large heads were often of stronger flavor than that of the smaller specimens. The Large and Medium lots produced many marketable heads and of a size suitable for market. The small roots yielded many small pencil-shaped heads which, though edible, would not pay for the trouble in handling. Table III shows the comparative weights of heads from the two

boxes. The head most desirable for market is from 4 to 6 inches long and weighs 2 to 3 ounces. In the Station test those roots whose crown diameter was within the limits of one to two inches produced the greatest proportion of satisfactory heads.

TABLE IV.— RELATION OF FORCED HEADS OF WITLOOF CHICORY TO ROOTS, IN WEIGHT AND QUALITY.

SIZE.	Number.	Total weight of heads.		Average weight of heads.	Percentage of marketable heads.
		Lbs.	*Ozs.*	*Ozs.*	*Per ct.*
Extra	22	7	2	5.18	50
Large	54	11	8	3.40	72
Medium	52	5	1	1.56	73
Small	44	2	9	.93	41

The length of time required for forcing the crop was 15 days, showing that a commercial crop can be grown in a comparatively short period and that several crops might be grown in the same soil during a winter season. Lower temperatures would undoubtedly lengthen the period required. Higher temperatures than those of Box 1 would probably result in a growth of long spindling leaves.

Sand proved a very satisfactory covering medium in that it is clean, is easily obtainable and promotes the formation of solid compact heads.

The space required per root is so small that a small area produces a valuable crop at present selling prices.

The Station crop of Witloof chicory was of the best quality, the heads being compact in shape and perfectly blanched. In the local market, which has in previous years handled imported Witloof extensively, the opinion was that this home grown product excelled the foreign grown in quality and freshness. The cultural requirements of Witloof are so simple that this crop well deserves much greater attention in the hands of home gardeners; and at present prices it cannot fail to give good financial returns to market gardeners.

CULTURE OF CABBAGE.*

J. W. WELLINGTON.

The cabbage crop is of great importance in certain areas of New York State — for example, on Long Island and in the Central Lake regions. In these districts large acreages are devoted to cabbage growing and special thought and energy are exercised in producing fine crops. The profits in cabbage growing are decidedly fluctuating from season to season, but growers have found the crop to be a good year in and year out investment. There are certain phases of the industry which need further study, notably the procuring of high-grade seed, proper planting methods and protection from insect and fungus pests.

The soil.— This vegetable is not particularly partial to any special soil type, succeeding on any well fertilized ground which is not subject to standing water. Drained soils will produce harder and better keeping heads than low, mucky types. A sweet soil is a necessity and all sour types should be treated with an application of raw ground limestone, in amounts as high as two or three tons per acre, depending on the acidity of the soil.

Preparation.— Successful cabbage growing demands a regular and consistent crop rotation — partly on account of fungus infection of soil and partly because of the heavy feeding habit of the crop. A four-year rotation is none too long and it is a good practice to have the crop follow a turned-under sod. Late fall or very early spring plowing is desirable and the soil should be harrowed frequently in early spring before setting season in order to destroy weeds and conserve moisture.

Fertilizers.— Cabbage is universally considered a heavy feeder and consequently liberal applications of plant food should be applied. Manure and fertilizers combined give excellent results, but where the former is not available, good crops may be raised on commercial fertilizers alone. The cabbage is especially benefited by phosphoric acid ingredients and fertilizers having a high content of this material should be selected. Dr. Jordan's[1] experiments in plant nutrition have shown that cabbages, rape and other cruciferous plants can utilize the raw ground rock phosphate to excellent advantage, and in consequence of the present high cost of the acid phosphate this is a most important point to cabbage and cauliflower growers. For hastening a late or slow-growing field there is nothing better than the use of two to three hundred pounds of nitrate of soda per acre.

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[1] New York Agricultural Experiment Station, Bul. 358.

* A reprint of Circular No. 48, February 15, 1916.

Plants.— The growing of good plants is at once a difficult and important step in cabbage culture. For early market varieties, it is essential to start the seedlings in hot beds or greenhouses, since the early crops are the ones that bring the profit. For the field or late crop the seed should be sown directly in the open in a seed-bed which has been thoroughly prepared and treated with a liberal application of good fertilizers. Previous to sowing, the seed should be soaked in a formaldehyde or corrosive sublimate solution in order to kill all disease spores that are often present on the coat of the seed. After soaking for fifteen or twenty minutes, the seed should be spread on a flat surface and dried — without artificial heat. The seed may be broadcasted or sowed in close rows, being careful not to sow too thickly. Many growers are adopting the practice of covering their beds with coarse-meshed cheesecloth, thus preventing the entrance of maggot flies and flea beetles. Any one interested in this protective measure should procure copies of this Station's Bulletins 301 and 334 on the screening of cabbage beds. Good plants are stepping stones to success and the investment in proper equipment is well justified.

Setting.— Extensive acreages are set with machine planters, requiring two horses and two or more men for operation. Smaller plantings of one or more acres may well be set by hand with the assistance of hand tools. A prominent Cortland County grower uses a hand planter which sets the plant and waters it at one operation. In the home garden the plants may be set with a dibble and pressed firm with hand or foot. The distances between plants and rows vary with the grower — in general it would be safe to say that late field varieties should be placed at least three feet between rows and twenty inches to two feet in the row. Hand setting is advantageous in that the rows may be set in two directions, thus affording opportunity for more horse work and less hand labor in culture.

Cultivation.— Frequent tillage in dry weather is one of the secrets of successful culture. Some of the best growers cultivate right up to within a week or so of the harvest, providing that the crop has not made sufficient growth. Where cultivation may be carried on in two directions, very little or no hand labor will be required and the breaking of a few leaves is not of sufficient harm to offset the benefit of tillage. Toward the end of the season the cultivator should be set shallow so as not to destroy the cabbage roots.

Disease.— Club root (*Plasmodiophora brassicae*), is the most common cabbage and cauliflower disease. It is manifested by an abnormal enlargement of the root and consequent poor growth of the plant. The leaves become pale and weak, further gain in size ceases and in severe stages the plant soon dies. This malady is best controlled by very long rotations in which crops of distinctly different nature occur such as timothy, clover, oats, potatoes, etc. It is also essential to keep prospective cabbage fields free from cruciferous weeds, wild mustard, etc. An important point is the selection

each year of a new clean piece of ground for the seed bed and thus to have healthy plants for the field.

Black rot (*Pseudomonas campestris*), when once established in a cabbage field, is an even more serious infection than the preceding. The first precaution to be observed is always to treat the seed in a solution of formaldehyde or mercury bichloride (corrosive sublimate). The formaldehyde is prepared at the rate of one pint of commercial formaldehyde to 25 gallons of water and the mercury solution at the rate of one ordinary drug-store tablet to one pint of water. The use of the mercury solution should be confined to a responsible person since the substance is a deadly poison if taken internally. The precaution of soaking the seed is particularly necessary with black rot in that the disease, if once established in the soil, persists there from year to year.

Phoma wilt (*Phoma oleracea*), also known as black leg, is a comparatively new cabbage disease in this section. The first symptoms are shown on the plants in the seed bed, in partly diseased condition of the root and peculiar reddish tinge to the leaves; generally all but a very few of the affected plants are discarded by the careful grower, yet a few may escape and carry the disease to the field. The roots of the half grown plants become blackened, nourishment is cut off and the leaves wither and drop and unless adventitious rootlets are pushed out from the stem the cabbage soon dies. The soaking of the seed is a necessary precaution against the spreading of the disease into new sections.

In regard to disease, the New York State growers are peculiarly fortunate in having an ideal cabbage climate and in practicing a system of farming which calls for a rotation of crops. Selection of strong healthy seed parents is proving to be an important point in combating disease.

Insects.— Flea beetles constitute a menace to young seedlings in that they literally riddle the leaves and thus destroy or seriously check the growth. Screening of the seed-bed is the surest preventive.

Maggots are not serious enemies of the fall cabbage except in their attack on the seedlings, which damage may be prevented by screening. The eggs are laid at the base of the young plant by the adult fly and soon hatch into white larvæ or maggots which eat the rootlets, thus causing the plant to wilt and die. The maggot is distinctly a menace to early cabbage culture and often may destroy 80 to 90 per ct. of the crop. This Station has found [2] that tarred paper pads properly placed about the base of plant after setting in the field will prevent the maggot injury.

Aphids constitute a serious pest of the cabbage — when present in sufficient numbers to do serious damage. The aphids suck the juices of the leaves causing the latter to roll and seriously hinder-

[2] New York Agricultural Experiment Station, Bul. 382.

ing normal growth. Black Leaf 40 and whale oil soap combined in the proportion of ¾ pint of the nicotine and 5 lbs. of the soap to 100 gallons of water is the most efficient remedy.[3] It is also found that proper nourishment of the crop, with consequent vigorous growth, is a factor in preventing damage.

The imported cabbage worm is one of the very common garden insects and in certain seasons works considerable damage on the cabbage crop. The butterflies are white, marked with black on the foretips of the wings. These insects may be noticed in great abundance in early spring and again in midsummer. The worms are of a velvety green color and when mature slightly over an inch in length. They are voracious eaters and a very few will work havoc on a cabbage head. The control is simple — lead arsenate three pounds, any brand of hard soap two pounds, water fifty gallons. Since the cocoons pass the winter beneath old cabbage leaves and rubbish, it is important to destroy all such waste materials.

The cabbage looper is also a serious enemy of the cabbage. Its work is particularly noticeable in late summer and the worm itself is distinguishable from the more common species by its looping habit of movement — similar to that of a measuring worm. The control measures are the same as given for the imported cabbage worm.

There is no danger from the use of arsenicals of the above proportions.

Harvesting.— Extensive fields are usually cut at one time — loading the good heads into wagons and carrying them directly to the storage or car. Small fields for local trade should be cut over at different intervals to obtain the ripe specimens. Many growers cut the hard head from the leafy portion and gather the latter for fodder. The method of harvesting is of little importance. It is essential, however, that only good, sound, uncracked heads should be sold in the first grade stock. Growers often go through their fields in early fall and if many heads are cracking, slightly lift the plants with the hands; this partial pulling stops root feeding and often delays too rapid maturity.

Storage.—As a general proposition it is probably wiser for the grower to sell his crop in the fall than to attempt to save it through the winter for higher spring prices. The loss in storage is often tremendous and unless facilities are good, it is sometimes quite impossible to keep the crop. In cabbage sections there are generally large commercial storage firms who buy the crop direct from grower and take chances for profit or loss upon themselves. Cabbage may be stored in home-made pits or right upon the ground surface by properly covering with strawy litter and soil. In this case the covering should be gradually added with the approach of winter cold and taken off as early in the spring as the warm heating days set in.

[3] New York Agricultural Experiment Station, Circ. 30.

Cabbage seed production.— The procuring of good seed is a difficult problem for the average grower. He is obliged to take whatever he can secure and often to his loss and disappointment. By saving the best heads, roots and all, from his field and keeping them through the winter and again setting the plants in the field in spring, the grower should be able to build up a strain of fine producing stock. There are certain growers practicing this method with success and finding a ready outlet for the surplus seed. This home grown seed has fully demonstrated its superiority over ordinary commercial stock.

VARIETIES.

Jersey Wakefield.— Earliest of all varieties. Size small; shape conical; quality very good. Valuable for very early market and home purposes.

Copenhagen Market.— Earliest round-headed variety. Size medium; stem very short; foliage light green; quality very good. Valuable new sort for market and home.

Rock Red.— Late variety of large size. Grown extensively wherever a red variety is in demand.

Flat Dutch.— Late variety. Heads attain an immense size. Shape roundish flattened; stem short; quality very good. Valuable market variety.

Danish Ball Head.— Late variety. Size medium; shape spherical with somewhat drawn-out base; quality very good. The leading storage variety on account of its splendid keeping quality.

Drumhead Savoy.— Medium to late variety. Size medium, distinguished from ordinary cabbage by its curled and crinkled leaves of bright vigorous green; quality very good.

REPORT

ON

INSPECTION WORK.

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TABLE OF CONTENTS.

I. Seed tests made at the Station during 1915.
II. Inspection of feeding stuffs.
III. Report of analyses of commercial fertilizers.

REPORT ON INSPECTION WORK.

SEED TESTS MADE AT THE STATION DURING 1915.*

M. T. MUNN.

SUMMARY.

Part I.— Of the 323 official samples of seed drawn from dealers' stocks by authorized representatives of the Commissioner of Agriculture 15, or 4.6 per ct., were found upon analysis to be violations of the seed law. The present seed law affords only a partial protection to the uninformed purchaser of seeds since it does not require a reasonable freedom from dodder or other noxious weed seeds, or from inert matter. Many of the lots of seed from which samples were drawn contained varying amounts of dodder seed or other weed seeds and because of the fact that they did not exceed the 3 per ct. limit of the seed law passed onto the market without labels to warn purchasers of the presence of seeds of these weed pests.

Part II.— The number of seed samples (777) received from correspondents for purity test is far below the number received during the previous year. This decrease in numbers is due to the cooperation with the seed laboratory of various organizations which made one person responsible for the purchase of a quantity of seed, and also to an apparent decrease in the number of small, worthless, free, advertizing samples of seed furnished to prospective buyers.

Samples of orchard grass seed showed that in some cases these goods have been intentionally adulterated with chaff and inert matter, while the Dwarf Essex rape seed had been adulterated with the cheap bird rape seed and other varieties of rape, and various kinds of mustard seed.

Dodder was found in one sample of orchard grass seed into which it had been intentionally introduced along with inert matter of various kinds. Over 10 per ct. of the alfalfa seed samples contained dodder, in one instance to the extent of 2.5 per ct.

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* A reprint of Bulletin No. 416, March, 1916.

I. INSPECTION OF AGRICULTURAL SEEDS.

Part I of this bulletin gives the results of the analyses of the official samples of agricultural seeds collected during the year 1915. These samples were collected under the provisions of Article 15 of the Agricultural Law and were transmitted for analysis to the Director of the New York Agricultural Experiment Station, in accordance with the provisions of Section 341 of said law.

These analyses and other additional information are published by the Director in accordance with said Section 341. Article 15 of the Agricultural Law, or what is known as the "Seed Law" will be found below, printed in full.

PROVISIONS OF THE AGRICULTURAL LAW RELATIVE TO THE INSPECTION AND SALE OF AGRICULTURAL SEEDS.

ARTICLE 15 OF THE AGRICULTURAL LAW.

INSPECTION AND SALE OF SEEDS.

Section 340. Inspection and sale of seeds.
341. Samples, publication of results of examination.

§ 340. **Inspection and sale of seeds.** Within the meaning of this article "agricultural seeds" are defined as the seeds of alfalfa, Canadian blue grass, Kentucky blue grass, alsike clover, crimson clover, red clover, white clover, vetch, orchard grass, rape, redtop, and timothy which are to be used for sowing or seeding purposes. No person, firm or corporation shall sell, offer, expose or have in his possession for sale for the purpose of seeding, any seeds of grasses or clovers, of the kind known as agricultural seeds, containing in excess of three per centum by weight of foul or foreign seeds, unless every receptacle, package, sack or bag containing such seeds is plainly marked or labeled with the per centum of such foul or foreign seeds contained therein. (As amended by chapter 59 of the Laws of 1916.)

§ 341. **Samples, publication of results of examination.** The commissioner of agriculture or his duly authorized representatives shall take samples of seed in triplicate in the presence of at least one witness and in the presence of such witness shall seal such samples and shall at the time of taking tender, and if accepted,

deliver to the person apparently in charge one of such samples; one of the other samples the commissioner of agriculture shall cause to be analyzed. The director of the New York agricultural experiment station shall analyze or cause to be analyzed such samples of seeds taken under the provisions of this article as shall be submitted to him for that purpose by the commissioner of agriculture and shall report such analysis to the commissioner of agriculture, and for this purpose the New York agricultural experiment station may employ experts and incur such expenses as may be necessary to comply with the requirements of this article. The result of the analysis of the sample or samples so procured, together with such additional information as circumstances advise, shall be published in reports or bulletins from time to time.

REPORT OF ANALYSES OF SAMPLES OF SEEDS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1915.

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Inert matter.	Pure seed.
	ALFALFA:	*Per ct.*	*Per ct.*	*Per ct.*
2157	Alfalfa. Brewster, Crittenden & Co., Rochester.	.16	.14	99.70
1235	Alfalfa. Burr & Starkweather Co., Rochester.	.14	.11	99.75
1929	Alfalfa. Harry G. Chapin, East Bloomfield.	.11	.10	99.79
1923	Alfalfa. Alex. Davidson, Canandaigua.	.18	.23	99.59
2059	Alfalfa. Philip Deuchler & Son, Lyons.	.12	.15	99.73
1228	Alfalfa. E. F. Dibble, Seed Grower, Honeoye Falls.	.01	.35	99.64
1926	Alfalfa. E. F. Dibble, Seed Grower, Honeoye Falls.	.06	.24	99.70
1753	Alfalfa. F. H. Ebeling, Syracuse.	.07	.14	99.79
2006	Alfalfa. Harvey Seed Co., Buffalo.	.04	.32	99.64
2010	Alfalfa. Henry & Missert, Buffalo.	2.22	.45	97.33
547	Alfalfa. B. F. Metcalf & Son, Chittenango.	.02	.20	99.78
1215	Alfalfa. M. F. Smith & Son, Hornell.	.10	.40	99.50
2090	Ace. The Shoemaker Co., Oakwood.	.58	.60	98.82

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Inert matter.	Pure seed.
	ALFALFA (*continued*):	*Per ct.*	*Per ct.*	*Per ct.*
1221	Anchor Wm. Hamilton & Son, Caledonia.	Trace	.11	99.89
1937	Best Webster D. Hatch, Holley.	.04	.65	99.31
1179	Best W. E. Owen & Son, Utica.	.30	.31	99.39
2106	Choice Percy Kerr Leggett Hardware Co., Cato.	.28	.32	99.40
1761	Choice C. F. Saul, Syracuse.	.06	.28	99.66
1773	Climax L. L. Patterson & Co., Syracuse.	Trace	.20	99.80
2152	Doxo The Maurer-Haap Co., Rochester.	.24	.05	99.71
1219	Empire Miller Bros. Co., Bergen.	.04	.21	99.75
1666	Eureka Daniel L. Ramsey & Son, Auburn.	.07	.25	99.68
1246	Eureka Perry C. Shafer Co., Brockport.	.10	.17	99.73
2198	Eureka State Agricultural & Industrial School, Industry.	.04	.14	99.82
2066	Fancy Beekman, Clary & Van Lieu, Dundee.	Trace	.15	99.85
1239	Fancy Burr & Starkweather Co., Rochester.	.07	.14	99.79
1921	Fancy Alex. Davidson, Canandaigua.	.04	.05	99.91
2200	Fancy B. F. French & Son, Attica.	.04	.20	99.76
1936	Fancy W. G. Hill, Attica.	.07	.40	99.53
2162	Fancy James Vick's Sons, Rochester.	.12	.30	99.58
1562	Fancy I. M. Young, Riverhead.	.01	.10	99.89
2069	Fancy American Grown T. M. Larsen, Dundee	Trace	.07	99.93
2103	Fancy Northern Grown C. C. Adams Sons, Weedsport.	.01	.30	99.69
1680	Gandy's Extra Fancy Schoonmaker Co., Seneca Castle.	.09	.23	99.68
1661	Globe Dean-Dillingham Co., Auburn.	.18	.34	99.48
2188	Globe Hickox Rumsey Co., Inc., Batavia.	.06	.16	99.78

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition. Foreign seed.	Inert matter.	Pure seed.
	ALFALFA (*concluded*):	*Per ct.*	*Per ct.*	*Per ct.*
1224	Honor Wm. Hamilton & Son, Caledonia.	Trace	.30	99.70
2064	Honor Ezra L. Horton & Clark H. Crosier, Penn Yan.	.02	.36	99.62
1667	Onondaga Auburn Flour & Feed Co., Auburn.	.11	.24	99.65
1931	Pan American Warren E. Moulton, Alexander.	.01	.29	99.70
1682	Pan American Ross A. Reynolds, Phelps.	.03	.40	99.57
2058	Pine Tree Charles Smart, Lyons.	.29	.01	99.70
1769	Strong's Fancy Recleaned A. M. Strong, Syracuse.	.08	.13	99.79
1248	Value Perry C. Shafer Co., Brockport.	2.11	.53	97.36
	ALSIKE:			
2011	Alsike Baker Bros., Andover.	1.47	.48	98.05
1687	Alsike Henry W. Bowes, Bath.	3.81	1.49	94.70
1234	Alsike Burr & Starkweather Co., Rochester.	1.43	.19	98.38
1164	Alsike Goddard & Jenkins, Schenevus.	.45	.46	99.09
1223	Alsike Wm. Hamilton & Son, Caledonia.	1.45	.51	98.04
1689	Alsike E. R. Hayssen Co., Seneca Falls.	.02 *1.07	.51	98.40
1690	Alsike E. R. Hayssen Co., Seneca Falls.	.49 *.90	.99	97.62
1919	Alsike Rufus A. Mather, Canandaigua.	.82	.75	98.43
2153	Alsike The Maurer-Haap-Co., Rochester.	.25	.30	99.45
1774	Alsike L. L. Patterson, Syracuse.	.52	.45	99.03
2098	Alsike D. L. Ramsey & Son, Auburn.	.22	.83	98.95
544	Alsike Irving T. Richer, New Berlin.	11.44	1.20	87.36
1216	Alsike M. F. Smith & Son, Hornell.	2.27	.64	97.09

* Crop seed.

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Inert matter.	Pure seed.
	ALISKE (*continued*):	*Per ct.*	*Per ct.*	*Per ct.*
2196	Alsike.................................... State Agricultural & Industrial School, Industry.	.28	1.27	98.45
2165	Alsike.................................... James Vick's Sons, Rochester.	.35	.37	99.28
1700	Alsike.................................... William Wilson, Geneva.	1.38	.69	97.93
1565	Alsike.................................... I. M. Young, Riverhead.	1.05	.32	98.63
1664	Ace.................................... Dean-Dillingham Co., Auburn.	2.05	.80	97.15
1915	Best.................................... Watson & Son, Warsaw.	1.47	1.35	97.18
2151	Brees.................................... The Maurer-Haap Co., Rochester.	2.80	.30	96.90
1905	Choice.................................... William G. Hill, Attica.	2.78	.17	97.05
2155	Clark.................................... Brewster Crittenden & Co., Rochester.	.27	.19	99.54
2122	C. M.................................... Glenn C. Wilder & J. R. Wilder, Painted Post.	.57 *3.25	.90	95.28
1913	Contract Prime.................................... William Watson & Son, Warsaw.	.71	.45	98.84
2185	Eureka.................................... J. Holley Bradish, Batavia.	.24	.50	99.26
1240	Export Fancy.................................... Burr & Starkweather Co., Rochester.	2.25	.33	97.42
1668	Export Fancy.................................... Webb J. Greenfield, Moravia.	1.87	.45	97.68
1683	Export Fancy.................................... Ross A. Reynolds, Phelps.	.55	.55	98.90
1675	Fancy.................................... Clyde Farmers' Exchange, Clyde.	.80	.22	98.98
1227	Fancy.................................... E. F. Dibble, Seed Grower, Honeoye Falls.	.26	.62	99.12
1927	Fancy.................................... E. F. Dibble, Seed Grower, Honeoye Falls.	.31	.47	99.22
1901	Fancy.................................... B. F. French & Son, Attica.	.57	.45	98.98
2194	Gandy's Extra Fancy.................................... Donald G. Fraser, Batavia.	.40	.57	99.03
2052	Globe.................................... Bridger & Wilcox, Phelps.	1.36	.59	98.05
1910	Globe.................................... A. A. Grinnell Co., Inc., Oakfield.	.95	.42	98.63

* Other crop seed.

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition. Foreign seed.	Inert matter.	Pure seed.
	Alsike (*concluded*):	*Per ct.*	*Per ct.*	*Per ct.*
537	Globe I. S. Matthews Sons, Binghamton.	.11	.55	99.34
2080	Imperial Claude Tucker & F. S. Line Estate, Wallace.	.60	.45	98.95
2156	O'Neil Brewster Crittenden & Co., Rochester.	.65	1.09	98.26
1172	Pan American Elmore Milling Co., Oneonta.	1.85	.62	97.53
2003	Pan American L. G. Miller & Sons, Olean.	2.07	.77	97.16
2195	Pine Tree W. W. Lawrence & Son, Corfu.	2.60	.73	96.67
2123	Pine Tree George W. Peck Co., Corning.	1.49	.42	98.09
2057	Pine Tree Charles Smart, Lyons.	2.74	.73	96.53
2097	Prime D. L. Ramsey & Son, Auburn.	.58	.17	99.25
1768	Strong's Fancy Recleaned A. M. Strong, Syracuse.	.62	.20	99.18
1932	Reliable George C. Broadbooks, Attica.	2.99	.27	96.74
2061	Value Philip Deuchler & Son, Lyons.	.40	.29	99.31
1245	Value Perry C. Shafer Co., Brockport.	.74	.55	98.71
1238	Alsike Clover with White Clover & Timothy Burr & Starkweather Co., Rochester.	.45 *2.09	.21	97.25
	Blue Grass:			
2116	Canada F. L. Jennings, Elmira.	2.90 *8.10	9.70	79.30
1763	Canada C. F. Saul, Syracuse.	2.60	8.65	88.75
1559	Canadian Weeber & Don, New York.	4.80	18.60	76.60
1232	Kentucky E. F. Dibble, Seed Grower, Honeoye Falls.	.15	21.72	78.13
2095	Kentucky W. J. Greenfield, Moravia.	.61	21.68	77.71
2128	Kentucky Kelly & Corcoran, Penn Yan.	.15	19.95	79.90
2004	Kentucky L. G. Miller & Sons, Olean.	.55	24.40	75.05
2102	Kentucky D. L. Ramsey & Son, Auburn.	.56	22.00	77.44

*Crop seed.

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Inert matter.	Pure seed.
	BLUE GRASS (*concluded*):	*Per ct.*	*Per ct.*	*Per ct.*
1766	Kentucky A. M. Strong, Syracuse.	.65	19.66	79.69
2079	Kentucky Clarence J. Tierney, Wallace.	.45	15.47	84.08
2172	Kentucky James Vick's Sons, Rochester.	.32	34.05	65.63
2173	Kentucky James Vick's Sons, Rochester.	.69	17.17	82.14
1557	Kentucky Weeber & Don, New York.	.50	14.92	84.58
1567	Kentucky I. M. Young, Riverhead.	.67	34.43	64.90
	CLOVER:			
2126	Crimson Kelly & Corcoran, Penn Yan.	.54	.94	98.52
1563	Crimson I. M. Young, Riverhead.	1.36	2.25	96.39
1662	Mammoth Dean-Dillingham Co., Auburn.	.18	.21	99.61
1226	Mammoth E. F. Dibble, Honeoye Falls.	.51	.21	99.28
1928	Mammoth E. F. Dibble, Honoeye Falls.	.08	.08	99.84
1755	Mammoth F. H. Ebeling, Syracuse.	.52	.26	99.22
1211	Mammoth Stephen Hollands & Sons, Hornell.	.13	.15	99.72
536	Mammoth I. S. Matthews Sons, Binghamton.	.22	.16	99.62
2084	Mammoth Stephen B. Merritt, Prattsburg.	.65	.20	99.15
2073	Mammoth Halsey P. Minor, Interlaken.	.69	.23	99.08
1167	Mammoth Morris Bros., Oneonta.	1.11	.68	98.21
1168	Mammoth Morris Bros., Oneonta.	1.39	.63	97.98
2178	Mammoth Francis P. Murray, Macedon.	.02	Trace	99.98
2076	Mammoth Geo. W. Peck Co., Cohocton.	2.60	.51	96.89
2077	Mammoth Clarence J. Tierney, Wallace.	.02	.04	99.94
2166	Mammoth James Vick's Sons, Rochester.	.50	.11	99.39
1250	Ace Mammoth H. O. Young & Son, Palmyra.	1.51	.74	97.75

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Inert matter.	Pure seed.
	CLOVER (*continued*):	*Per ct.*	*Per ct.*	*Per ct.*
1697	Ace Mammoth P. Maloney & Son, Red Creek.	.70	.45	98.85
543	Atlas Mammoth Irving L. Richer, New Berlin.	1.35	.70	97.95
2108	Choice Mammoth Harvey T. Matson, Crocketts.	.60	.50	98.90
1764	Contract Mammoth C. F. Saul, Syracuse.	.26	.11	99.63
2083	Defiance Mammoth Stephen B. Merritt, Prattsburg.	.94	.67	98.39
1673	Fancy Mammoth Hawkins Hardware Co., Geneva.	.14	.12	99.74
2086	Gandy's Mammoth Geo W. Peck Co., Bath.	.68	.30	99.02
1767	Genuine Peavine Mammoth A. M. Strong, Syracuse.	.32	.26	99.42
2053	Globe Mammoth Bridger & Wilcox, Phelps.	.53	.15	99.32
1218	Honor Mammoth Wm. Hamilton & Son, Caledonia.	.40	.43	99.17
2111	Imperator Mammoth Cornelius Van Allen, Watkins.	1.35	.40	98.25
2118	Kaiser Mammoth William T. Coleman, Elmira.	1.05	.53	98.42
1698	Lion Mammoth William H. Paddock, Wolcott.	1.22	.51	98.27
1912	Lion Mammoth Watson & Son, Warsaw.	2.04	.40	97.56
2070	Onondaga Mammoth T. M. Larsen, Dundee.	.94	.22	98.84
1174	Pan American Mammoth Elmore Milling Co., Oneonta.	1.35	.63	98.02
2159	Star Mammoth Brewster Crittenden & Co., Rochester.	.36	.50	99.14
2100	Star Mammoth D. L. Ramsey & Son, Auburn.	1.22	.59	98.19
2175	Star Mammoth E. Williamson Mercantile Co., E. Williamson.	.30	.35	99.35
2164	Toll Mammoth James Vick's Sons, Rochester.	.53	.28	99.19
2180	Value Medium Barnhart & Fuller, Fairport.	.50	.10	99.40
1685	Medium Henry W. Bowes, Bath.	2.71	1.46	95.83
1236	Medium Burr & Starkweather Co., Rochester.	.37	.17	99.46
1231	Medium E. F. Dibble, Honeoye Falls.	.08	.14	99.78

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Inert matter.	Pure seed.
	CLOVER (*continued*):	*Per ct.*	*Per ct.*	*Per ct.*
1925	Medium E. F. Dibble, Honeoye Falls	.15	.50	99.35
1754	Medium F. H. Ebeling, Syracuse.	.26	.11	99.63
1175	.... Elmore Milling Co., Oneonta.	4.36	1.80	93.84
1938	Medium Webster D. Hatch, Holley.	.32	.12	99.56
1692	Medium E. R. Hayssen Co., Seneca Falls.	.10	.18	99.72
2009	Medium Henry & Missert, Buffalo.	1.20	.72	98.08
1212	Medium Stephen Hollands & Son, Hornell.	.13	.15	99.72
2105	Medium Percy Kerr Leggett Hardware Co., Cato.	.09	.14	99.77
1669	Medium D. L. Ramsey & Son, Auburn.	.36	.35	99.29
1243	Medium Perry C. Shafer Co., Brockport.	.29	.27	99.44
1217	Medium M. F. Smith & Son, Hornell.	.25	.21	99.54
2197	Medium State Agricultural & Industrial School, Industry.	.07	Trace	99.93
2078	Medium Clarence J. Tierney, Wallace.	.02	.04	99.94
2160	Medium James Vick's Sons, Rochester.	.38	.24	99.38
2161	Medium James Vick's Sons, Rochester.	.40	.48	99.12
1566	.... I. M. Young, Riverhead.	1.10	.47	98.43
2067	Ace Medium Beekman Clary & Van Liew, Dundee.	1.14	.70	98.16
1663	Ace Dean-Dillingham Co., Auburn.	1.03	.77	98.20
1249	Ace Medium C. A. Sessions & Son, Palmyra.	.76	.54	98.70
2091	Ace Medium The Shoemaker Co., Oakwood.	1.40	.14	98.46
1222	Anchor Medium Wm. Hamilton & Son, Caledonia.	.07	.12	99.81
1918	A. R. C. Medium Rufus A. Mather, Canandaigua.	1.64	.48	97.88
2055	Arc Medium John L. Rogers & Arthur E. Sucher, Lyons.	.63	.31	99.06

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition. Foreign seed.	Inert matter.	Pure seed.
	CLOVER (*continued*):	*Per ct.*	*Per ct.*	*Per ct.*
2092	Arc Medium Frank E. Saxton, Venice Center.	.42	.66	98.92
2107	Choice Medium Bertram D. Banker Hardware Co., Meridian.	1.61	1.50	96.89
1904	Choice Medium William G. Hill, Attica.	.60	.42	98.98
1762	Choice Medium C. F. Saul, Syracuse.	1.89	1.	97.11
2075	Crown Medium Humphrey Courtney, Atlanta.	.30	.24	99.46
2176	Crown Medium Charles J. Servoss, Macedon.	.24	.10	99.66
1930	Eli Medium Wheeler Bros., Holcomb.	.32	.26	99.42
2181	Elk Medium Briscoe and Tupper, Churchville.	.37	.10	99.53
2056	Elk Medium John L. Rogers & Arthur E. Sucher, Lyons.	.73	.27	99.00
1220	Eureka Medium Miller Bros. Co., Bergen.	.22	.24	99.54
2002	Eureka L. G. Miller & Sons, Olean.	.30	.08	99.62
1771	Eureka L. L. Patterson & Co., Syracuse.	.14	.35	99.51
1684	Eureka Medium Ross A. Reynolds, Phelps.	.05	.26	99.69
1244	Eureka Medium Perry C. Shafer Co., Brockport.	.21	.18	99.61
1670	Extra Fancy Medium Dorchester & Rose, Geneva.	.31	.30	99.39
2005	Fancy Harvey Seed Co., Buffalo.	.07	1.39	98.54
2169	Fancy James Vick's Sons, Rochester.	.26	.69	99.05
1903	Fancy Medium B. F. French & Son, Attica.	1.03	.36	98.61
1672	Fancy Medium Hawkins Hardware Co., Geneva.	.11	.18	99.71
2174	Fancy Peavine The J. H. Strait Milling Co., Inc., Canisteo.	.35	.21	99.44
1686	Gandy's Fancy Medium Henry W. Bowes, Bath.	.27	.08	99.65
2087	Gandy's Choice Medium Geo. W. Peck Co., Bath.	1.69	.62	97.69
2192	Gandy's Extra Fancy Medium Donald G. Fraser, Batavia.	.46	.28	99.26
2193	Gandy's Standard A. Fancy Donald G. Fraser, Batavia.	.30	.24	99.46

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Inert matter.	Pure seed.
	CLOVER (*concluded*).	*Per ct.*	*Per ct.*	*Per ct.*
1681	Gandy's Extra Fancy No. 10................ Schoonmaker Co., Seneca Castle.	.22	.10	99.68
1919	Globe Medium.......................... A. A. Grinnell Co., Inc., Oakfield.	.57	.23	99.20
1693	Globe Medium.......................... E. R. Hayssen Co., Seneca Falls.	.44	.18	99.38
2190	Honor Medium.......................... Hickox Rumsey Co., Inc., Batavia.	.70	.40	98.90
2186	Honor Medium.......................... Hickox Rumsey Co., Inc., Batavia.	.84	.36	98.80
1699	Lion Medium........................... William H. Paddock, Wolcott.	1.11	.31	98.58
1914	Lion Medium........................... Watson & Son, Warsaw.	.44	.30	99.26
1765	Onondaga Medium....................... C. F. Saul, Syracuse.	.20	.03	99.77
1173	Pan American Medium................... Elmore Milling Co., Oneonta.	2.31	.63	97.06
2065	Pan American.......................... Horton & Crosier, Penn Yan.	1.38	.60	98.02
1242	Pine Tree Medium...................... H. S. Bushnell, Brockport.	.28	.37	99.35
1691	Pine Tree Medium...................... E. R. Hayssen Co., Seneca Falls.	.28	.22	99.50
2060	Prime Medium.......................... Philip Deuchler & Son, Lyons.	.61	.18	99.21
2093	Reliable Selected..................... Auburn Flour & Feed Co., Auburn.	1.34	.97	97.69
2167	Reliable Medium....................... Joseph Meehan, Batavia.	.76	.22	99.02
1908	Selected Medium....................... A. A. Grinnell Co., Inc., Oakfield.	.98	.68	98.34
2099	Star Medium........................... D. L. Ramsey & Son, Auburn.	1.04	.73	98.23
2158	Star Medium........................... Brewster Crittenden & Co., Rochester.	.90	.32	98.78
1676	White................................. Ayres & Knapp, Elmira.	1.15	.72	98.13
2183	White................................. J. Holley Bradish, Batavia.	2.65	.82	96.53
1169	White................................. Morris Bros., Oneonta.	1.82	.94	97.24
2096	White................................. A. J. Nicht, Aubu-n.	12.40	2.93	84.67
2163	White................................. James Vick's Sons, Rochester.	12.94	.28	86.78

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Inert matter.	Pure seed.
	ORCHARD GRASS:	Per ct.	Per ct.	Per ct.
1230	Orchard Grass............................ E. F. Dibble, Seed Grower, Honeoye Falls.	5.85	17.35	76.80
2115	Orchard Grass............................ F. L. Jennings, Elmira.	1.88	23.32	74.80
2089	Orchard Grass............................ Geo. W. Peck Co., Bath.	.67	18.62	80.71
2082	Orchard Gass, Choice.................... Clarence Tucker & F. S. Line Estate, Wallace.	1.45	20.02	78.53
2081	Orchard Grass, Prime.................... Clarence Tucker & F. S. Line Estate, Wallace.	3.35 *.65	16.60	79.40
1558	Orchard Grass............................ Weeber & Don, New York.	1.85	14.00	84.15
1564	Orchard Grass............................ I. M. Young, Riverhead.	1.52	23.32	75.16
	RAPE:			
2154	Dwarf Essex.............................. Crosman Bros., Rochester.	None	.18	99.82
2088	Dwarf Essex.............................. Geo. W. Peck Co., Bath.	.16	.24	99.60
1935	Dwarf Essex.............................. T. C. Smyth, Leroy.	.03	2.79	97.18
1688	Dwarf Essex.............................. E. R. Hayssen Co., Seneca Falls.	.07	1.26	98.67
	RED TOP:			
1233	Fancy.................................... E. F. Dibble, Seed Grower, Honeoye Falls.	.85	7.48	91.67
1757	Climax................................... F. H. Ebeling, Syracuse.	6.25	10.10	83.65
2184	Fancy.................................... J. Holley Bradish, Batavia.	1.66	10.03	88.31
2113	Fancy.................................... Thomas Hibbard Co., Horsehead.	5.75	13.85	80.40
1165	Fancy.................................... Morris Bros., Oneonta.	2.13	8.12	89.75
2051	Fancy.................................... William Wilson, Geneva.	1.60	9.24	89.16
1560	Fancy.................................... I. M. Young, Riverhead.	5.80	14.80	79.40
2120	Unhulled................................. William H. Ferguson & Son, Elmira.	5.27	66.78	27.95

* Blue grass.

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Inert matter.	Pure seed.
	TIMOTHY (*continued*):	*Per ct.*	*Per ct.*	*Per ct.*
1752	Globe, Bright Hulled F. H. Ebeling, Syracuse.	.10	.04	99.86
1696	Globe P. Maloney & Son, Red Creek.	.03	.04	99.93
535	Globe I. S. Matthews Sons, Binghamton.	.17	.11	99.72
539	Honor Matthew H. Beardsley, New Berlin.	.10	.22	99.68
2189	Honor Hickox Rumsey Co., Inc., Batavia.	.11	.23	99.66
1176	Honor Chas. H. Poole, Rome.	.25	.17	99.58
1171	Imperator Elmore Milling Co., Oneonta.	1.95	.27	97.78
2110	Imperator Cornelius Van Allen, Watkins.	2.95	.30	96.75
538	King Ertell E. Franklin, Whitney Point.	.10	.21	99.69
2068	King T. M. Larsen, Dundee.	.41	.21	99.38
2177	King C. A. Sessions & Son, Palmyra.	.22	.20	99.58
1907	Leah Brewster Crittenden & Co., Rochester.	.15	.20	99.65
540	Liberty Selected Matthew H. Beardsley, New Berlin.	.24	.21	99.55
1933	Liberty Recleaned George C. Broadbooks, Attica.	.04	.22	99.74
1694	Liberty Selected Gray Bros., North Rose.	.21	.20	99.59
2063	Liberty Selected Horton & Crosier, Penn Yan.	.25	.28	99.47
541	No. 10 Matthew H. Beardsley, New Berlin.	.47	.65	98.88
2071	Onondaga T. M. Larsen, Dundee.	.17	.14	99.69
1759	Onondaga Charles F. Saul, Syracuse.	.12	.13	99.75
1940	Oriole John T. Darrison & Co., Lockport.	.25	.17	99.58
2085	Oriole Stephen B. Merritt, Prattsburg.	.15	.85	99.00
1678	Pan American Frederick L. Jennings, Elmira.	.70	.26	99.04
2001	Pan American L. G. Miller & Sons, Olean.	.15	.52	99.33
1920	Pan American The Peck Hardware Co., Canandaigua.	.80	.42	98.78

ANALYSES OF SAMPLES OF SEEDS COLLECTED (*continued*).

Number.	Kind of seed, brand or trade name, name of dealer, and place of collection.	Composition.		
		Foreign seed.	Inert matter.	Pure seed.
	TIMOTHY (*continued*):	*Per ct.*	*Per ct.*	*Per ct.*
1237	Blue Jay Burr & Starkweather Co., Rochester.	.15	.25	99.60
1677	Bon Frederick L. Jennings, Elmira.	.17	.20	99.63
2179	Bon J. M. McMahon, Fairport.	.16	.35	99.49
1674	Choice Hawkins Hardware Co., Geneva.	.10	.21	99.69
1906	Choice William G. Hill, Attica.	.75	.42	98.83
2054	Choice Maloney Bros., Waterloo.	.62	.35	99.03
2104	Choice Percy Kerr Leggett Hardware Co., Cato.	.85	.37	98.78
1760	Choice C. F. Saul, Syracuse.	.66	.26	99.08
1911	Churchill's Fancy Ballintine Hardware Co., Warsaw.	.04	.32	99.64
1917	Churchill's Fancy Cheney & McGee, Warsaw.	.03	.27	99.70
2124	Churchill's Fancy Aaron F. Williams, Corning.	.15	.19	99.66
1772	Climax L. L. Patterson & Co., Syracuse.	.45	.34	99.21
1758	Columbia C. F. Saul, Syracuse.	.19	.25	99.56
2119	Eutopia William H. Ferguson & Son, Elmira.	.19	.15	99.66
2191	Gandy's Extra Fancy Donald G. Fraser, Batavia.	.30	.25	99.45
1679	Gandy's Extra Fancy Schoonmaker Co., Seneca Castle.	.20	.25	99.55
2182	Gold Medal J. H. Bradish, Batavia.	13.47	1.67	84.86
1170	Gold Medal Elmore Milling Co., Oneonta.	.08	.15	99.77
2109	Gold Medal E. R. Love & Son, Watkins.	.19	.17	99.64
2008	Comet Henry & Missert, Buffalo.	.30	.25	99.45
1561	Don I. M. Young, Riverhead.	2.02	.41	97.57
1756	Fancy F. H. Ebeling, Syracuse.	.27	.25	99.48
1902	Fancy B. F. French & Son, Attica.	.12	.14	99.74
1751	Globe F. H. Ebeling, Syracuse.	Trace	.01	99.99

of the samples collected during 1912 were violations of the seed law, while there were 17.5 per ct. of violations in 1913, 10.9 per ct. in 1914 and only 4.6 per ct. in 1915. It is to be remembered, also, that the greater proportion of the samples which prove to be violations do not represent seeds which are especially objectionable for seeding purposes since in many cases the crop seed is contaminated with another crop seed of about the same size and weight and often of equal or higher value. On the other hand, a considerable number of the samples which pass the very lenient requirements of the seed law are contaminated with dodder and other noxious weeds, the amount often closely approximating 3 per ct. by weight,—sufficient to make the crop seed very objectionable for seeding purposes.

Many different kinds of labels are used in tagging the various packages, bags and lots of seed upon the market. The present seed law does not designate what information the label must convey to the prospective buyer except that the percentage of foul or foreign seed must be stated when it exceeds 3 per ct. by weight. Some labels found upon lots of seed indicate the nature and kind of seed impurity in the crop seed while others classify it as foreign seed. The former method is to be preferred since it is of importance to know whether the seed is that of another crop seed of value and not weed seeds. It is also of more importance for the buyer to know, for instance, that blue grass seed contains a comparatively heavy and low priced seed like timothy, than it is to know that there is white clover seed in alsike clover seed where the weight and value of the seeds compare favorably.

In general, the samples analyzed during 1915 revealed approximately the same seed trade conditions as prevailed during 1914; that is to say, but very little protection was afforded the purchaser of seeds since the lots of seed which contained small amounts of very noxious or objectionable weed seeds passed onto the market without tags or identification marks to warn the purchaser, while those lots of seed which contained over 3 per ct. of foul or foreign seed (which in most cases was another crop seed of similar size and shape) required labels to satisfy the requirements of the present seed law, which is very lenient in this respect.

II. VOLUNTARY EXAMINATIONS FOR CORRESPONDENTS.

During the past year, 777 samples of seed have been received from correspondents and analyzed for purity. The greater proportion of the samples were those of alfalfa, alsike clover, red clover and timothy. In addition to these there were 71 miscellaneous samples representing 19 kinds of seed. The number of samples received during the year is considerably smaller than that of the previous year when 1155 samples were received from the same source. This decrease in number of samples submitted for analysis appears to be due to the facts that, (1) there is an increasing amount of labeled seeds upon the market because of the inspection law. These labeled goods are offered by reputable seed dealers whose brand mark or purity test serves as a guaranty of the seeds sold under such tags; (2) there is a marked decrease in the number of small, carefully cleaned, advertizing samples of seed distributed to prospective buyers. Farmers are regarding such samples with much suspicion and are not buying their seeds upon the results of analyses made upon these unrepresentative samples; (3) farmers' cooperative associations, granges, farm bureau managers and other special purchasing agents have cooperated with the seed laboratory by sending one carefully mixed sample from large lots of seed which they purchased for their respective organizations.

In a number of instances large shipments of seeds have been held in the cars on the track awaiting a report of purity test. Such a procedure is to be commended since it serves as a protection to farmers and extends the benefits to be derived from the seed laboratory. A few analyses were made for seed dealers but these only on special request and where it was feared that noxious weed seeds were contained in the large shipments of seed — in some cases car lots.

SEED TRADE CONDITIONS DURING 1915.

It appears that the shortage of seeds due to stoppage of imported goods brought all grades of stock onto the market. Much old and impure seed was found. Red clover samples contained an unusually large number and variety of weed seeds, some of which, because of their noxious character, made the crop seed worthless for seeding purposes. Samples of timothy seed did not show their usual freedom from weed seeds, many bad weed seeds being found in these samples.

Orchard grass samples analyzed showed a very deplorable condition as regards quality. The low percentage of pure seed being due mainly to the presence of excessive amounts of chaff and similar inert matter.

The rape seed samples showed that in some instances the cheap bird rape seed had been substituted for the valuable Dwarf Essex or winter rape. Considerable mustard seed of various kinds was also found in these samples.

DODDER FOUND IN SEED SAMPLES.

Over 10 per ct. of the alfalfa seed samples examined contained seeds of dodder. One sample of alfalfa seed which purported to be western-grown seed contained over 2.5 per ct. small-seeded dodder. Dodder seeds were found in 3 per ct. of the red clover seed samples, and one sample of alsike clover contained seeds of this noxious weed.

One sample of orchard grass seed was found to contain the large-seeded dodder. The presence of the dodder seeds, other weed seeds and the excessive amount of inert matter could be explained only upon the ground that they were intentionally introduced into the orchard grass seed for the purpose of giving it weight.

REPORT OF ANALYSES OF SAMPLES OF COMMERCIAL FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916.*

There are presented in this bulletin the analyses of samples of fertilizers collected by the Commissioner of Agriculture during 1916, and transmitted by him for analysis to the Director of the New York Agricultural Experiment Station, in accordance with the provisions of Article 9 of the Agricultural Law. These analyses and the accompanying information are published by said Director in accordance with the provisions of Section 224 of said Law.

In previous years it has been customary to give figures showing the current values of fertilizer ingredients as a basis for determining the approximate commercial valuation of different brands; but, owing to the serious interference of the war with supplies of fertilizing materials and the consequent increase of cost, it was decided by the experiment stations of New England and the Middle States that it would be impracticable to prepare any schedule of trade-values covering conditions during the past year.

* A reprint of Bulletin No. 425, October, 1916.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
AMERICAN AGRICULTURAL CHEMICAL Co., NEW YORK, N. Y.						
14% Acid Phosphate		G*	——	14	15	——
Albion	6692	F*	——	14.58	15.24	——
16% Acid Phosphate		G	——	16	17	——
Binghamton	01152	F	——	15.82	16.84	——
Acid Phosphate 18%		G	——	18	19	——
Salem	01918	F	——	17.86	18.16	——
Acme Early Crop Producer		G	4.11	8	9	1
L. I. City	01737	F	4.56	8.30	9.10	0.64
Acme Long Island Vegetable & Potato Grower		G	3.29	10	11	——
Jamaica	01724	F	3.28	10.54	11.60	——
Ammoniated Fertilizer A		G	0.82	10	11	——
Binghamton	01151	F	1.05	9.91	10.55	——
Ammoniated Fertilizer AAA		G	2.47	10	11	——
Malone	5270	F	2.56	10.53	11.75	——
Ammoniated Fertilizer AAAA		G	3.29	10	11	——
Oneonta	0327	F	3.38	10.16	11.50	——
Bradley's B. D. Sea Fowl Guano 1916		G	0.82	10	11	1
Penn Yan	0173	F	0.92	11.40	12.20	0.85
Bradley's Complete Manure for Potatoes and Vegetables 1916		G	3.29	9	10	1
Elmira	0755	F	3.02	10.59	11.11	0.90
Bradley's Eclipse Phosphate 1916		G	1.23	10	11	1
Fairport	0156	F	1.60	10.47	11.87	0.90
Bradley's Golden Crop Compound		G	2.47	10	11	——
Rome	6746	F	2.46	10.37	11.59	——
Bradley's New Method Fertilizer 1916		G	0.82	8	9	1
Stittville	6724	F	0.89	9.27	10.73	0.66

* These letters indicate, respectively, Guaranteed and Found.

Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken.	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid Available	Phosphoric acid Total	Potash
American Agricultural Chemical Co., New York, N. Y. (*continued*)						
Bradley's Patent Superphosphate 1916		G*	2.06	8	9	1
Locke	01253	F*	2.07	9.48	10.40	0.92
Bradley's Potato Manure 1916		G	2.47	9	10	1
Stittville	6723	F	2.43	10.46	10.46	0.93
Bradley's Tobacco Manure without Potash		G	4.53	3	4	——
Owego	01235	F	4.52	3.54	4.12	——
Bradley's Truckers Delight		G	3.29	10	11	——
Roxbury	01675	F	3.30	10.98	12.14	——
Bradley's Unicorn 1916		G	1.65	9	10	1
Fairport	0157	F	1.57	9.66	10.90	0.98
Clark's Cove King Philip Alkaline Guano 1916		G	0.82	8	9	1
Orchard Park	01052	F	0.84	8.62	10.36	0.80
Crocker's Complete Manure 1916		G	0.82	10	11	1
Bergen	01856	F	0.86	11.27	12.11	0.96
Crocker's Harvest Jewel Fertilizer 1916		G	1.65	9	10	1
Canastota	01274	F	1.64	10.40	11.72	0.92
Crocker's High Grade Special 1916		G	1.65	10	11	1
Bergen	01857	F	1.65	11.72	12.14	0.82
Crocker's New Rival Fertilizer 1916		G	1.23	10	11	1
Rome	6744	F	1.33	10.92	11.94	0.98
Crocker's Potato, Hop and Tobacco Fertilizer 1916		G	2.06	10	11	1
Castle Creek	01228	F	2.21	10.28	11.42	0.94
Crocker's Special Potato Fertilizer 1916		G	3.29	9	10	1
Castle Creek	01227	F	3.14	9.62	10.76	0.95

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y. (*continued*)						
Crocker's Universal Grain Grower 1916		G*	0.82	8	9	1
Rome	6745	F*	0.88	8.30	9.51	0.96
Crocker's Wheat and Corn Fertilizer 1916		G	2.06	8	9	1
Argyle	01911	F	2.06	9.20	10.38	0.88
Darling's Pride of Long Island		G	3.29	10	11	——
East Quogue	0996	F	3.39	10.34	11.64	——
East India Corn King 1916		G	2.47	9	10	1
Cortland	01240	F	2.64	10.38	11.42	0.84
East India Early Market		G	2.47	10	11	——
Bovina Centre	01677	F	2.43	10.93	12.29	——
East India Economizer Phosphate 1916		G	0.82	8	9	1
Binghamton	01153	F	0.93	8.88	10.54	0.86
East India Mayflower 1916		G	1.65	9	10	1
Cortland	01239	F	1.78	10.02	10.70	0.95
East India Potato & Garden Manure		G	3.39	9	10	1
New Hyde Park	01734	F	3.52	9.14	10.42	0.98
East India Unexcelled Fertilizer 1916		G	2.06	8	9	1
Bovina Centre	01676	F	2.04	9.00	10.16	0.86
East India Victor Special 1916		G	3.29	10	11	——
Sherburne	01206	F	3.50	10.34	11.72	——
Fine Ground Bone		G	2.47	——	22.88	——
New York	01701	F	2.51	——	23.70	——
Golden Top Dresser		G	8.23	5	6	——
Long Island City	01738	F	8.34	6.08	6.88	——
Great Eastern Dissolved Acid Phosphate		G	——	14	15	——
Sherburne	01207	F	——	14	14.86	——

* These letters indicate, respectively, Guaranteed and Found.

Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
American Agricultural Chemical Co., New York, N. Y. (*continued*)						
Great Eastern Early Cabbage		G*	5.76	8	9	1
Jamaica	01727	F*	6.04	7.84	9.52	0.99
Great Eastern Garden Special 1916		G	3.29	9	10	1
Jamaica	01728	F	3.41	9.04	10.14	1.02
Great Eastern General 1916		G	0.82	8	9	1
South Fallsburgh	01670	F	0.88	9.51	11.05	0.67
High Grade Ground Bone		G	3.29	——	20.59	——
New York	01702	F	3.57	——	22.03	——
Homestead Good Grower		G	2.06	8	9	——
Watkins	0449	F	2.13	10.63	11.33	——
Homestead Good Grower		G	2.06	8	9	——
Orchard Park	01053	F	2.07	7.50	9.22	——
Lazaretto High Grade Truck Manure 1916		G	2.06	10	11	1
West Webster	0180	F	2.08	11.38	11.98	1.14
Michigan Carbon Wks. General Crop Fertilizer 1916		G	0.82	10	11	1
Fredonia	6636	F	1.06	10.82	12.14	0.95
Michigan Carbon Wks. Homestead Fertilizer 1916		G	2.06	8	9	1
North Collins	01882	F	2.09	9.10	10.64	1.04
Michigan Carbon Wks. Homestead Potato & Tobacco Fertilizer		G	2.06	10	11	1
Middleport	6650	F	2.14	10.78	11.88	1
Milsom's Bison Brand 1916		G	1.65	10	11	1
Mumford	0779	F	1.71	11.60	12.10	0.66
Milsom's Corn Fertilizer 1916		G	2.47	9	10	1
North Collins	01881	F	2.45	10.86	11.34	0.81

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid Available	Phosphoric acid Total	Potash
AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y. (*continued*)						
Milsom's Potato and Cabbage Manure 1916		G*	0.82	10	11	1
Albion	6607	F*	0.83	11.56	12.42	0.96
Milsom's Potato, Hop & Tobacco Fertilizer 1916		G	2.06	8	9	3
Andes	01673	F	1.95	7.66	8.80	2.97
Milsom's Soil Enricher 1916		G	1.65	9	10	1
Albion	6609	F	1.71	10.51	11.71	1
Milsom's Special Buffalo Guano		G	.82	8	9	3
Andes	01674	F	.87	8.08	9.38	3
Milsom's Wheat, Oats & Barley Fertilizer 1916		G	.82	8	9	1
Albion	6606	F	.82	9.01	10.81	0.94
North Western Challenge Fertilizer 1916		G	0.82	10	11	1
Oneonta	0329	F	1.04	9.94	11.22	1.02
North Western Complete Compound 1916		G	0.82	8	9	1
Oneonta	0328	F	1.15	9.53	10.49	0.86
North Western Garden Manure 1916		G	3.29	9	10	1
North Norwich	01203	F	3.12	9.74	10.70	0.90
North Western Homestead Fertilizer 1916		G	2.06	8	9	1
Mountaindale	01672	F	2.04	8.84	10.04	1.06
North Western Red Line Fertilizer 1916		G	2.47	9	10	1
North Norwich	01202	F	2.05	10.04	11.04	0.83
North Western Shawnee Phosphate 1916		G	1.65	9	10	1
Watkins	0448	F	1.62	10.15	10.83	0.86

* These letters indicate, respectively, Guaranteed and Found.

Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid Available	Phosphoric acid Total	Potash
American Agricultural Chemical Co., New York, N. Y. (*continued*)						
Odorless Grass & Lawn Top Dressing 1916		G*	3.70	8	9	1
Albany	01935	F*	3.72	8.95	9.51	0.61
Pacific Nobsque Guano 1916		G	0.82	8	9	1
Palmyra	0152	F	0.84	10.78	12.26	0.98
Packers Union Superior Acid Phosphate		G	——	14	15	——
Union	01223	F	——	14.26	15.06	——
Potomac Complete Manure 1916		G	1.65	9	10	1
New York	P 206	F	2.05	10.32	11.90	0.84
Potomac General Crop Compound 1916		G	2.47	9	10	1
New York	P 204	F	2.56	9.60	11	1.08
Quinnipiac Ammoniated Dissolved Bone 1916		G	1.65	9	10	1
Stephentown	01933	F	1.63	10.17	11.21	1.06
Quinnipiac "B" Fertilizer 1916		G	1.23	10	11	1
Eden Center	01876	F	1.37	10 44	11.86	1.04
Quinnipiac Climax Phosphate 1916		G	0.82	8	9	1
Webster	0181	F	0.92	9.72	11.28	0.95
Quinnipiac Market Garden Manure 1916		G	3.29	9	10	1
Webster	0182	F	3.33	10.36	10.84	0.92
Quinnipiac Mohawk Fertilizer 1916		G	0.82	10	11	1
Stephentown	01932	F	0.98	11.26	12.42	0.98
Quinnipiac Potato Phosphate 1916		G	2.06	8	9	1
Webster	0183	F	2.02	9.78	11.16	0.88
Read's All Crops Fertilizer 1916		G	0.82	10	11	1
Copenhagen	6867	F	1.00	10.76	12.08	1

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid Available	Phosphoric acid Total	Potash
AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y. (*continued*)						
Read's Corn, Wheat and Rye 1916		G*	1.65	9	10	1
Hooper	01167	F*	1.63	9.90	11	0.92
Read's Farm and Garden Manure		G	2.47	10	11	——
Verona Station	6747	F	2.37	10.66	12.10	——
Read's Farmers Friend Superphosphate 1916		G	2.06	8	9	1
Orchard Park	01051	F	2.05	9.32	9.74	0.61
Read's Leader Fertilizer		G	0.82	8	9	1
Hooper	01166	F	0.83	8.22	9.52	1
Read's Pioneer Fertilizer 1916		G	1.23	10	11	1
Copenhagen	6866	F	1.22	10.64	11.60	0.94
Read's Top Notch Mixture		G	3.29	10	11	——
Manlius	01283	F	3.50	11.03	12.35	——
Read's Vegetable and Vine Fertilizer 1916		G	2.47	9	10	1
Lowville	6868	F	2.45	10.15	11.07	1.18
Special Cabbage & Cauliflower Fertilizer 1916		G	4.11	8	9	——
Orient	0989	F	4.05	8.52	9.08	——
Special Cabbage & Cauliflower Fertilizer 1916		G	4.11	8	9	——
Bridgehampton	0994	F	4.14	8.44	9.70	——
Wheeler's Corn Fertilizer 1916		G	1.65	10	11	1
Manlius	01284	F	1.77	11.06	11.84	1
Wheeler's High Grade Acid Phosphate		G	——	16	17	——
Erin	0795	F	——	15.97	16.89	——
Wheeler's Peerless Acid Phosphate		G	——	14	15	——
Manlius	01286	F	——	14.98	15.86	——

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN.	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y. (*concluded*)						
Wheeler's Royal Wheat Grower 1916		G*	0.82	8	9	1
Manlius	01285	F*	0.84	9.12	10.34	0.80
Williams & Clark's Americus Potato Manure 1916		G	2.06	8	9	1
Berlin	01930	F	2.07	9.56	10.52	0.90
Williams & Clark's Elk Brand 1916		G	0.82	10	11	1
Berlin	01929	F	1.26	10.56	11.70	0.90
Williams & Clark's Matchless Fertilizer 1916		G	1.65	9	10	1
Hamburg	01871	F	1.70	9.06	10.10	0.94
Williams & Clark's Special Prolific Crop Producer		G	0.82	8	9	1
South Plymouth	01234	F	1.23	8.73	10.48	0.94
Zell's Economizer Phosphate 1916		G	0.82	8	9	1
North Greece	0783	F	1.00	8.75	10.24	0.86
AMERICAN FERTILIZING CO., BALTIMORE, MD.						
10% Acid Phosphate		G	——	10	11	——
Batavia	01863	F	——	10.08	11.04	——
12% Acid Phosphate		G	——	12	13	——
Batavia	01864	F	——	12.05	13.29	——
American Ammoniated Phosphate		G	1.05	10	11	——
Eden Center	01877	F	1.16	9.70	10.78	——
American Champion Ammoniated Superphosphate		G	1.65	10	11	——
Eagle	6625	F	1.74	9.77	11.07	——
American Eagle Ammoniated Compound		G	2.47	10	11	——
Industry	0778	F	2.28	10.06	11.56	——
American Eagle Crop Grower		G	1.65	8	9	2
Pittsford	0769	F	1.83	8.17	9.79	2.26

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
AMERICAN FERTILIZING CO., BALTIMORE, MD. (*continued*)						
American Eagle Special Ammoniated Compound		G*	1.65	12	13	——
Rushville	0771	F*	1.55	12.25	14.21	——
American Fish & Bone Compound		G	1.65	8	9	3
Springville	6682	F	1.75	9.08	10.90	2.82
American Fish & Bone Compound Revised		G	1.65	8.50	9.50	1
Industry	0777	F	1.71	8.89	10.49	0.86
American Fish & Bone Compound Revised		G	1.65	8.50	9.50	1
Apulia	01288	F	1.66	9.04	10.92	0.98
American Fish and Bone Special		G	1.65	11	12	——
Rushville	0772	F	1.80	11.46	12.88	——
American Grain & Grass Ammoniated Phosphate		G	0.82	12	13	——
Bemus Point	01899	F	1.75	14.15	15.55	——
American Grain & Grass Grower Revised		G	0.82	9	10	1
Eden Center	01878	F	0.86	8.44	10.52	1.12
American High Grade Acid Phosphate		G	——	16	17	——
Sherburne	01205	F	——	16.48	17.04	——
American Reliable Guano		G	0.82	8	9	1
Dansville	0758	F	0.93	7.70	9.52	1.24
Ammoniated Bone Compound		G	0.82	8	9	2
Naples	0774	F	1.00	9.28	10.78	1.70
High Grade Acid Phosphate		G	——	14	15	——
Springville	6683	F	——	15	15.52	——
High Grade Acid Phosphate		G	——	14	15	——
Avoca	0200	F	——	15.19	16.29	——

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER: Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
AMERICAN FERTILIZING CO., BALTIMORE, MD. (*concluded*)						
Steamed Bone		G*	——	——	——	——
Eagle	6626	F*	2.84	——	24.04	——
ARMOUR FERTILIZER WORKS, BALTIMORE, MD.						
Armour's 1¼-9		G	1.23	9	9.50	——
Boonville	6851	F	1.23	9.26	9.87	——
Armour's 2-8-1		G	1.65	8	8.50	1
Homer	01171	F	1.48	8.29	9.09	0.97
Armour's 2-11		G	1.65	11	11.50	——
Lockport	6615	F	1.80	10.90	11.70	——
Armour's 2.50-8-1		G	2.06	8	8.50	1
Bliss	6627	F	2.07	7.78	9.42	1.24
Armour's 3-8-1		G	2.47	8	8.50	1
Beacon	01977	F	2.53	8.02	8.72	0.94
Armour's 4-8		G	3.29	8	8.50	——
Hempstead	01735	F	3.12	8.04	8.84	——
Armour's 4-10		G	3.29	10	10.50	——
Lockport	6614	F	3.23	10.19	10.94	——
Armour's 5-4-1		G	4.11	4	4.50	1
Corning	0754	F	3.88	5.07	5.93	1.14
Armour's 5-10		G	4.11	10	10.50	——
Mineola	01739	F	4.27	10.54	11.06	——
Armour's Acid Phosphate Fertilizer		G	——	16	16.50	——
Homer	01170	F	——	16.92	16.94	——
Armour's Grain Grower Fertilizer		G	1.65	8	8.50	2
Barneveld	6725	F	1.65	7.71	8.19	2.00
Armour's Organic Guano Fertilizer		G	2.25	4.62	5.50	——
Yonkers	01968	F	2.20	5.78	9.40	——

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer: Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
ARMOUR FERTILIZER WORKS, BALTIMORE, MD. (*concluded*)						
Armour's Star Phosphate Fertilizer		G*	——	14	14.50	——
Homer	01169	F*	——	13.78	14	——
Armour's Wheat, Corn and Oat Special Fertilizer		G	0.82	7	7.50	1
Chateaugay	5272	F	0.86	7.08	7.60	1.06
Bone Meal		G	2.47	——	22	——
Avon	0789	F	2.57	——	22.04	——
Ground Tankage		G	4.93	——	13.74	——
Yonkers	01969	F	4.91	——	14.90	——
Nitrate of Soda		G	14.81	——	——	——
Pine Island	01991	F	15.45	——	——	——
Raw Bone Meal		G	3.70	——	21.50	——
Eden Center	01875	F	3.91	——	24.20	——
Raw Bone Meal		G	3.70	——	22	——
Yonkers	01970	F	3.90	——	24.52	——
ATLANTIC FERTILIZER WORKS, BALTIMORE, MD.						
Atlantic One Eight Naught Brand		G	0.82	8	——	——
Bridgewater	6738	F	0.92	7.76	8.76	——
Atlantic Two Ten Naught Brand		G	1.65	10		——
Bridgewater	6737	F	1.87	8.50	9.70	——
ATLANTIC PACKING CO., SYRACUSE, N.Y.						
Atlantic Animal Brand		G	2.46	11	12	——
Brocton	6633	F	2.65	10.81	13.50	——
Atlantic Garden and Truck Manure		G	3.28	11	12	——
Brocton	6634	F	3.20	11.38	12.54	——
Atlantic Grass & Grain Brand for Oats & Buckwheat		G	0.82	11	12	——
Lyons Falls	6854	F	0.87	11.14	11.30	——

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid Available	Phosphoric acid Total	Potash
ATLANTIC PACKING CO., SYRACUSE, N. Y. (*concluded*)						
Atlantic Ground Bone		G*	2.45	——	23	——
Brocton	6635	F*	2.93	——	22.73	——
Atlantic High Grade Potato		G	2.87	10	11	——
Brocton	6632	F	2.92	10.26	11	——
Atlantic Reliable Brand		G	1.64	9	10	——
Jordan	01300	F	1.93	8.88	9.70	——
Atlantic Superior Brand		G	1.24	10	11	——
Lyons Falls	6855	F	1.35	9.86	10.06	——
Atlantic Vegetable Brand for Celery, Cabbage and Potatoes		G	2.05	11	12	——
North Norwich	01197	F	2.08	11.60	12.10	——
BAUGH & SONS CO., PHILADELPHIA, PA.						
Baugh's 16% Acid Phosphate		G	——	16	——	——
Binghamton	01154	F	——	15.83	16.09	——
Baugh's Ammoniated Superphosphate		G	1.02	10	——	——
Hammondsport	0753	F	1.21	10.37	11.89	——
Baugh's Ammoniated Superphosphate		G	1.03	10	——	——
Skaneateles	01273	F	1.12	9.76	11.38	——
Baugh's Animal Base and Potash Compound for all Crops		G	1.65	9	——	1
McDougall	01337	F	1.81	8.30	12.10	1.18
Baugh's Corn and Oats Fertilizer		G	1.65	10	——	——
Troy	5349	F	1.81	10.44	13.18	——
Baugh's Corn & Oats Fertilizer		G	1.65	10	——	——
Ellenville	01655	F	1.62	10.62	12.74	——
Baugh's Excelsior Guano		G	1.02	10	——	1
Westtown	01986	F	1.07	10.86	12.90	1.08

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid Available	Phosphoric acid Total	Potash
BAUGH & SONS CO., PHILADELPHIA, PA. (*continued*)						
Baugh's Export Bone with Potash		G*	1.65	——	11	1
McDougall	01338	F*	2.06	8.17	12.13	0.95
Baugh's Fine Ground Bone		G	2.47	——	16.49	——
Binghamton	01157	F	2.97	——	16.59	——
Baugh's General Crop Grower for all Crops		G	0.82	8	——	1
Binghamton	01156	F	0.84	8.08	9.64	1.10
Baugh's Half & Half Mixture		G	1.23	——	19	——
Locke	01254	F	1.40	——	19.08	——
Baugh's High Grade Acid Phosphate		G	——	14	——	——
Irondequoit	0442	F	——	14.88	15.76	——
Baugh's High Grade Acid Phosphate		G	——	14	——	——
Binghamton	01217	F	——	16.57	17.37	——
Baugh's High Grade Ammoniated Animal Base		G	3.30	10	——	——
Trumansburg	01295	F	3.16	9.96	10.52	——
Baugh's High Grade Ammoniated Animal Base		G	3.30	10	——	——
Ellenville	01654	F	3.78	11.26	13.70	——
Baugh's High Grade Potato Grower		G	3.30	8	——	1
Irondequoit	0444	F	3.28	9.54	10.86	0.99
Baugh's New Process 10% Guano		G	8.23	6	10	——
Hoosick Falls	01928	F	7.17	6.78	7.82	——
Baugh's Peninsula Grain Producer		G	0.82	9	——	——
Benton	0196	F	0.92	8.16	10.82	——
Baugh's Potato and Truck Special for all truck crops		G	2.88	10	——	1
Irondequoit	0445	F	2.79	10.52	11.42	1.14

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
BAUGH & SONS CO., PHILADELPHIA, PA. (*continued*)						
Baugh's Pure Dissolved Animal Bones		G*	2.06	13	——	——
Williamson	0188	F*	2.08	14.16	15	——
Baugh's Pure Dissolved Animal Bones		G	2.06	13	——	——
Westtown	01988	F	2.23	14.16	15	——
Baugh's Pure Steamed Bone		G	1.65	——	25	——
Seneca Falls	01304	F	1.37	——	28.64	——
Baugh's Raw Bone Meal		G	3.70	——	21.50	——
Irondequoit	0446	F	3.75	——	20.52	——
Baugh's Special Potato Manure		G	1.65	10	——	1
Westtown	01987	F	1.67	11.03	12.87	1.12
Baugh's The Old Stand-By Dissolved Animal Base		G	1.65	12	——	——
Binghamton	01155	F	1.90	12.53	14.61	——
Baugh's The Old Stand-By Dissolved Animal Base		G	1.65	12	——	——
Locke	01255	F	1.78	11.89	14.41	——
Baugh's Trucker's Favorite		G	2.47	10	——	——
Trumansburg	01296	F	2.51	9.73	10.92	——
Baugh's Trucker's Favorite		G	2.47	10	——	——
Ellenville	01656	F	2.47	10.69	13.11	——
Baugh's Trucker's Favorite		G	2.47	10	——	——
Schuylerville	01913	F	2.47	9.94	11.72	——
Baugh's Trucker's Favorite		G	2.47	10	——	——
Monroe	01978	F	2.46	9.62	11.62	——
Fine Ground Blood		G	9.88	——	——	——
Rochester	0199	F	8.23	——	——	——
Fine Ground Blood		G	9.87	——	——	——
Binghamton	01218	F	9.89	——	——	——

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
				Phosphoric acid		
			Nitrogen	Available	Total	Potash
BAUGH & SONS CO., PHILADELPHIA, PA. (*concluded*)						
High Grade Tankage		G*	7.40	——	4	——
Oneida	01281	F*	6.69	——	10.13	——
Nitrate of Soda		G	15.23	——	——	——
Irondequoit	0443	F	15.68	——	——	——
Nitrate of Soda		G	15.23	——	——	——
Binghamton	01219	F	15.34	——	——	——
BERG COMPANY, THE, PHILADELPHIA, PA.						
Berg's Animal Bone & Meat		G	3.30	——	17	——
Ossining	01965	F	3.70	——	16.94	——
Berg's Raw Bone Fine		G	3	——	22	——
Ossining	01964	F	3.49	——	18.85	——
BERKSHIRE FERTILIZER CO., BRIDGEPORT, CONN.						
Berkshire Ammoniated Bone Phosphate		G	0.80	8	9	——
Arlington	01981	F	1.28	8.64	9.00	——
Berkshire Dry Ground Fish		G	8.23	——	6	——
Arlington	01982	F	8.29	——	6.36	——
Berkshire Long Island Special		G	3.30	8	9	2
Poughkeepsie	01985	F	3.53	8.92	9.04	3
Berkshire Market Garden Fertilizer		G	3.30	8	9	——
Poughkeepsie	01984	F	3.77	7.78	8.02	——
Berkshire Potato and Vegetable Phosphate		G	1.70	8	9	——
Arlington	01983	F	1.81	7.50	8.14	——
Berkshire Root Fertilizer		G	2.50	8	9	——
Greenlawn	0965	F	2.85	8.57	8.91	——
Berkshire Root Fertilizer		G	2.50	8	9	——
Arlington	01980	F	3.30	9.95	11.27	——

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer: Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
BOWKER FERTILIZER CO., NEW YORK, N. Y.						
Bowker's 16% Acid Phosphate		G*	——	16	17	——
Castile	01869	F*	——	15.94	16.60	——
Bowker's All Round Fertilizer 1916		G	2.06	10	11	1
Fort Henry	01910	F	2.11	10.19	11.19	0.92
Bowker's Ammoniated Food for Flowers		G	2.47	6	7	2
Rochester	0160	F	2.52	6.46	7.50	2.59
Bowker's Extra Superphosphate with Ammonia		G	1.65	12	13	——
Fairport	0153	F	1.77	12.10	14.30	——
Bowker's Farm & Garden Phosphate 1916		G	1.65	10	11	1
Bedford Hills	01954	F	1.70	10.49	12.09	1
Bowker's Fresh Ground Bone		G	2.47	——	22.88	——
Huntington	0966	F	2.48	——	25.34	——
Bowker's Fresh Ground Bone		G	2.47	——	22.88	——
Bedford Hills	01955	F	2.48	——	25.65	——
Bowker's Hill and Drill Phosphate 1916		G	2.47	9	10	1
Fulton	6872	F	2.46	9.64	10.54	0.72
Bowker's Lawn and Garden Dressing 1916		G	4.11	8	9	1
Rochester	0162	F	4.20	12.21	19.61	0.98
Bowker's Potato Phosphate 1916		G	1.65	10	11	1
Hamlin	0780	F	1.85	10.04	11.84	0.83
Bowker's Soluble Phosphate		G	——	14	15	——
Castile	01868	F	——	14.22	15.08	——
Bowker's Staple Phosphate 1916		G	0.82	8	9	1
Fairport	0155	F	0.83	10.58	12.16	0.90

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
BOWKER FERTILIZER CO., NEW YORK, N. Y. (*concluded*)						
Bowker's Superphosphate with Ammonia 1%		G*	0.82	10	11	——
Fairport	0154	F*	0.80	9.90	11.28	——
Bowker's Superphosphate with Ammonia 1%		G	0.82	10	11	——
Maine	01222	F	1.00	9.96	11.12	——
Bowker's Superphosphate with Ammonia 2%		G	1.65	10	11	——
Attica	6605	F	1.64	9.97	11.45	——
Bowker's Superphosphate with Ammonia 3%		G	2.47	10	11	——
Amsterdam	5325	F	2.44	9.96	11.28	——
Bowker's Superphosphate with Ammonia 4%		G	3.29	10	11	——
Fulton	6874	F	2.98	10.46	11.42	——
Bowker's Superphosphate with Ammonia 5%		G	4.11	8	9	——
Riverhead	0960	F	3.80	8.34	9.62	——
Bowker's Sure Crop Phosphate 1916		G	0.83	10	11	1
Stillwater	01902	F	0.95	10.91	12.31	0.93
CARPENTER, JOHN M., ELMIRA, N. Y.						
Carpenter's Tankage		G	6.57	——	6 93	——
Elmira	0450	F	6.87	——	10.54	——
CASE & CO., INC., A. H., BUFFALO, N. Y.						
Excelsior Brand Pulverized Pig Manure		G	1	1	——	1
North Collins	01884	F	1.65	1.86	——	1
Excelsior Brand Pulverized Sheep Manure		G	1	0.87	——	1
Dunkirk	6601	F	2.10	1.61	1.77	1.70

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*).

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN.	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
CENTRAL CHEMICAL CO., THOMAS FERT. WKS., HAGERSTOWN, MD.						
C C C Dissolved Bone		G*	2.05	13	——	——
Freeville	01184	F*	2.12	11.92	14.32	——
C C C Dissolved Bone		G	2.05	13	——	——
Hayt's Corners	01259	F	2.10	11.96	14.62	——
C C C Dissolved Phosphate		G	——	14	——	——
Owego	01160	F	——	14.53	14.85	——
C C C Dissolved Phosphate		G	——	16	——	——
Nichols	01163	F	——	16.14	16.62	——
C C C Fish Bone Compound		G	1.25	10	——	——
Hayt's Corners	01261	F	1.24	10.01	11.25	——
C C C Golden Sheaf		G	0.82	8	——	1
Penn Yan	0192	F	1.10	8.28	9.44	1.12
C C C Planters Mixture		G	1.65	10	——	1
Penn Yan	0191	F	1.68	9.64	10.88	1.20
C C C Pride of the Valley		G	0.82	10	——	——
Owego	01159	F	1.00	9.89	10.69	——
C C C Special Bone Mixture		G	1.65	10	——	——
Kendaia	01256	F	1.80	9.30	11.12	——
C C C Truck Special		G	2.50	10	——	——
Hayt's Corners	01260	F	2.46	10.04	10.98	——
CHEMICAL PRODUCTS CO., SCRANTON, PA.						
Special Potash Ash		G	——	——	3.10	0.46
Amenia	01992	F	——	——	2.79	0.76
CHITTENDEN CO., THE E. D., BRIDGEPORT, CONN.						
Chittenden's High Grade Potato without Potash		G	4.12	10	11	——
Mattituck	0981	F	4.15	10	12.52	——

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken.	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
CHITTENDEN CO., THE E. D., BRIDGEPORT, CONN. (*concluded*)						
Chittenden's Potato Special without Potash		G*	3.29	10	11	——
Mattituck	0980	F*	3.27	9.77	11.37	——
Vegetable & Onion Grower without Potash		G	2.47	10	11	——
Eastport	0990	F	2.45	8.07	12.61	——
CLARK & SON, O. W., BUFFALO, N. Y.						
Clark's Velvet Lawn Fertilizer		G	2.47	6	——	1
Buffalo	6644	F	2.56	8.25	9.07	2.90
Plant Food		G	3.50	7	——	6
Buffalo	6643	F	4.32	8.92	9.30	7.62
COE-MORTIMER CO., THE, NEW YORK, N. Y.						
E. Frank Coe's Columbian Corn and Potato Fertilizer 1916		G	1.23	10	11	1
Hamilton	01198	F	1.24	10.08	11.22	0.98
E. Frank Coe's Corn King 1916		G	2.06	10	11	1
Delhi	01678	F	2.35	10.73	11.55	0.80
E. Frank Coe's Gardeners and Truckers Special 1916		G	4.11	8	9	——
Broadalbin	01936	F	4.09	8.42	9.76	——
E. Frank Coe's Gold Brand Excelsior Guano 1916		G	2.47	9	10	1
Myers	01329	F	1.76	10.32	11.44	1
E. Frank Coe's High Grade Ammoniated Superphosphate 1916		G	2.47	10	11	——
Amenia	0498	F	2.59	10.62	12.06	——
E. Frank Coe's High Grade Soluble Phosphate		G	——	14	15	——
Batavia	01860	F	——	14.16	14.92	——

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
COE-MORTIMER CO., THE, NEW YORK, N. Y. (*concluded*)						
E. Frank Coe's Morco Top Dresser 1916		G*	8.23	5	6	1
Castle Creek	01220	F*	8.42	5.75	6.42	1.08
E. Frank Coe's Morco Top Dresser without Potash 1916		G	8.23	5	6	——
Claverack	01993	F	9.00	5.95	6.66	——
E. Frank Coe's New Englander Special 1916		G	0.82	8	9	1
Hamilton	01199	F	0.90	9.58	10.84	1.10
E. Frank Coe's Original Ammoniated Dissolved Phosphate 1916		G	1.65	10	11	——
Batavia	01859	F	1.84	10.08	11.32	——
E. Frank Coe's Prolific Crop Producer 1916		G	3.29	10	11	——
Hamilton	01201	F	3.32	10.26	11.68	——
E. Frank Coe's 16% Super Phosphate		G	——	16	17	——
Wyoming	01866	F	——	16.52	17.08	——
E. Frank Coe's Universal Fertilizer 1916		G	1.65	9	10	1
McLean	01319	F	1.74	9.87	10.99	0.82
E. Frank Coe's XXV Ammoniated Superphosphate 1916		G	0.82	10	11	——
Batavia	01858	F	1.00	9.61	10.25	——
E. Frank Coe's XXX Fine Ground Bone		G	2.47	——	22.88	——
Hemlock	0792	F	2.52	——	22.90	——
Fine Ground Bone		G	2.47	——	22.88	——
Fillmore	6622	F	2.48	——	25	——
High Grade Dried Blood		G	9.87	——	——	——
Silver Creek	6640	F	9.88	——	——	——

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken.	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
COLUMBIA GUANO CO., BALTIMORE, MD.						
Columbia 14% Acid Phosphate		G*	——	14	14.50	——
Amsterdam	5328	F*	——	14.58	15.66	——
Columbia High Grade 16% Acid Phosphate		G	——	16	16.50	——
Amsterdam	5331	F	——	16.23	16.81	——
Columbia Hornbill Ammoniated Superphosphate		G	3.29	8	8.50	——
Amsterdam	5330	F	3.21	8.22	10.42	——
Columbia Miracle Ammoniated Superphosphate		G	1.65	10	10.50	——
Amsterdam	5329	F	1.85	11.44	11.98	——
Columbia Reflex Ammoniated Superphosphate		G	0.82	10	10.50	——
Port Byron	01297	F	0.89	10.08	10.80	——
Columbia Wheat, Corn & Grass Special Fertilizer		G	0.82	8	8.50	1
Amsterdam	5327	F	1.12	8.24	8.94	0.91
CONSUMERS CHEMICAL CORPORATION, NEW YORK, N. Y.						
Consumers High Grade Acid Phosphate		G	——	16	17	——
Cortland	01186	F	——	16.32	16.52	——
Consumers Pure-Sure Acid Phosphate		G	——	14	15	——
Cortland	01185	F	——	15.09	15.33	——
Consumers Pure-Sure Ammoniated Bone Phosphate		G	1.65	10	11	——
Harford	01225	F	1.73	10.40	11.73	——
Consumers Pure-Sure Corn & Grain Bone Phosphate		G	1.65	12	13	——
Cortland	01188	F	1.67	12.68	13.98	——

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
CONSUMERS CHEMICAL CORPORATION, NEW YORK, N. Y. (*concluded*)						
Consumers Pure-Sure Corn & Vegetable (with 1% Potash)		G*	2.47	8	9	1
Cortland	01189	F*	2.64	8.49	9.77	1.45
Consumers Pure-Sure Corn & Vegetable (without Potash)		G	2.47	10	11	——
Cortland	01187	F	1.98	9.76	12.59	——
Consumers XXX Fish & Potash Mixture		G	1.65	8	9	1
Cortland	01190	F	1.82	10.09	11.13	1.08
Consumers Pure-Sure Potato Manure (without Potash)		G	4.12	10	11	——
Harford	01224	F	3.02	9.30	11.16	——
DAY, MRS. R. WHITE, ARLINGTON, N. Y.						
Pure Bone & Meat Fertilizer		G	2.50	——	10	——
Arlington	01976	F	2.40	——	15.68	——
DOLD PACKING CO., JACOB, BUFFALO, N. Y.						
Dold Quality Bone Meal		G	2.47	——	23	——
Saratoga	01906	F	2.90	——	23.27	——
ENTERPRISE GUANO CO., BALTIMORE, MD.						
Enterprise Champion Fertilizer		G	1.65	10	——	——
Weedsport	01303	F	1.67	10.38	11.24	——
Enterprise Eagle Fertilizer		G	0.82	10	——	——
Weedsport	01301	F	0.86	10.06	10.52	——
Enterprise 14 Per Cent Acid Phosphate		G	——	14	——	——
New Berlin	01233	F	——	13.28	13.38	——
Enterprise Superior Acid Pohsphate		G	——	16	——	——
New Berlin	01232	F	——	15.05	15.18	——
Enterprise Victor Fertilizer		G	2.47	10	——	——
Weedsport	01302	F	2.50	10.27	11.25	——

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
HENDERSON & CO., PETER, NEW YORK, N. Y. (*concluded*)						
Henderson's Worm Killing Grass Food		G*	2.36	0.40	0.70	1.80
New York	01705	F*	2.56	0.64	0.70	1.71
The Henderson Lawn Enricher War Special		G	2.47	3.50	4.50	1
New York	01703	F	2.49	4.51	5.87	1.39
HESS & BRO., INC., S. M., PHILADELPHIA, PA.						
Ammoniated Superphosphate 1916		G	1.65	9	10	1
Jamestown	6602	F	1.63	9.63	10.97	1.20
Farmers' General Fertilizer 1916		G	0.82	10	11	1
Darien Center	01054	F	0.82	10.92	12.52	0.94
High Grade Super-Phosphate		G	3.29	10	11	——
Hicksville	01746	F	3.32	11.31	12.69	——
Market Gardener's Manure		G	4.11	8	9	——
Hicksville	01745	F	4.22	9.71	10.11	——
Nitrate of Soda		G	15	——	——	——
East Williamson	0786	F	15.50	——	——	——
Potato Manure 1916		G	2.47	9	10	1
Hicksville	01748	F	2.65	10.50	11.42	0.82
Reliable Super Phosphate		G	2.47	10	11	——
Cortland	01324	F	2.42	9.10	11.64	——
Special Corn Manure 1916		G	0.82	10	11	1
Jamestown	6604	F	0.83	11.68	12.41	1.01
Special Fish & Potash Manures 1916		G	2.06	8	9	1
Hicksville	01744	F	2.30	9.22	10.40	1.77
Special High Grade Acid Phosphate		G	——	16	17	——
Cortland	01323	F	——	15.96	16.92	——
Special Potato Manure 1916		G	3.70	8	9	1
Mineola	01719	F	3.68	8.64	9.82	1.26

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
HESS & BRO., INC., S. M., PHILADELPHIA, PA. (*concluded*)						
Standard Super Phosphate		G*	0.82	10	11	——
Cortland	01322	F*	0.95	10.08	11.68	——
Superior Super Phosphate		G	1.65	10	11	——
Cortland	01321	F	1.83	9.17	11.19	——
Top Dressing Manure		G	8.23	5	6	——
Hicksville	01747	F	8.92	5.78	6.46	——
Wheat and Grass Manure 1916		G	0.82	10	11	1
Jamestown	6603	F	0.92	11.61	12.45	0.95
HUDSON CARBON CO., BALLSTON SPA, N. Y.						
Davidge's Concentrated Manure		G	1	——	1	——
Nyack	0491	F	1.53	——	8.22	——
Davidge's Special Phosphorus		G	——	——	5	——
Glens Falls	01905	F	——	——	11.37	——
INTERNATIONAL AGR'L CORPORATION, BUFFALO FERTILIZER WORKS, BUFFALO, N. Y.						
Bone Meal		G	2.40	——	22	——
Randolph	6699	F	2.18	——	24.36	——
Buffalo One Eight Two		G	0.80	8	9	2
Springville	6690	F	1.02	7.82	9.34	1.92
Buffalo One Eight Three		G	0.80	8	9	3
Springville	6688	F	1.00	7.71	8.65	3.01
Buffalo Two Eight Three		G	1.60	8	9	3
Springville	6687	F	1.68	7.85	8.89	3.26
Buffalo Ten Two		G	——	10	11	2
Springville	6685	F	——	10.22	10.52	1.98
Buffalo Twelve Two		G	——	12	13	2
Springville	6684	F	——	12.10	12.40	2.08

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
INTERNATIONAL AGR'L CORPORATION, BUFFALO FERTILIZER WORKS, BUFFALO, N. Y. (*continued*)						
Buffalo Ammoniated Phosphate		G*	1.20	12	13	——
Penn Yan	0166	F*	1.23	12.90	13.24	——
Buffalo Bone Meal		G	2.40	——	22	——
Penn Yan	0168	F	2.75	——	20.15	——
Buffalo Dissolved Phosphate		G	——	14	15	——
Altamont	5346	F	——	14.67	14.93	——
Buffalo Dried Blood		G	13.20	——	——	——
Fairport	0785	F	11.68	——	——	——
Buffalo Farmers Choice		G	0.80	10	11	——
Ogdensburg	5268	F	0.87	10.22	10.82	——
Buffalo Farmers Choice		G	0.80	10	11	2
Springville	6686	F	1.04	10.64	11.60	2.14
Buffalo Garbage Tankage		G	2.30	4	——	0.75
Taberg	6742	F	2.75	2.45	3.29	1.27
Buffalo Garden Truck		G	3.30	9	10	——
Frewsburg	01890	F	3.19	10.39	11.23	——
Buffalo General Favorite		G	0.80	8	9	1
Fonda	5333	F	0.80	8.22	8.82	0.90
Buffalo High Grade Manure		G	3.30	8	9	3
Springville	6689	F	2.91	8.23	9.72	3.08
Buffalo Ideal Wheat & Corn		G	1.60	10	11	——
Randolph	6700	F	1.62	10.63	11.94	——
Buffalo Sixteen Per Cent		G	——	16	17	——
Penn Yan	0165	F	——	16.20	16.40	——
Buffalo Top Dresser		G	5.80	6	7	——
Frewsburg	01891	F	4.83	6.73	7.80	——
Buffalo Truck and Onion		G	2.40	10	11	1
Altamont	5347	F	2.42	11.62	12.28	1

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken.	Number		Pounds in 100 Pounds of Fertilizer: Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
INTERNATIONAL AGR'L CORPORATION, BUFFALO FERTILIZER WORKS, BUFFALO, N. Y. (*concluded*) .						
Buffalo Vegetable & Potato		G*	2.50	10	11	——
Taberg	6743	F*	2.47	10.70	11.96	——
Nitrate of Soda		G	15	——	——	——
Jamestown	6647	F	15.54	——	——	——
INTERNATIONAL SEED CO., ROCHESTER, N. Y.						
International Electric Fertilizer		G	0.82	8	9	1
Remsen	6722	F	1.11	9.03	10.51	1.30
International General Phosphate		G	1.65	10	11	——
Huntington	0967	F	1.72	9.84	11.12	——
International Grain & Grass Fertilizer		G	1.03	9	10	1
Remsen	6721	F	1.16	10.90	11.60	0.94
International Potato & Truck Manure		G	1.85	8	9	1
Maine	01221	F	2.00	8.95	9.55	1
JARECKI CHEMICAL CO., THE, SANDUSKY, O.						
Ammoniated Phosphate		G	0.82	10	——	——
Sherman	6628	F	0.86	10.43	11.93	——
Black Diamond Fish Guano		G	1.65	8	——	1
Gasport	6616	F	1.68	7.89	9.55	1.08
Cereala		G	1.65	12	——	——
Gasport	6617	F	1.63	11.19	13.09	——
C. O. D. Phosphate		G	——	14	——	——
Hilton	0781	F	——	13.40	14.44	——
Fish and Potash Truck Manure		G	3.30	8	——	1
South Lima	0791	F	3.25	8.36	10.06	1.18
Little Giant		G	0.82	7	——	1
Newfane	6618	F	0.83	7.28	8.08	1.21

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
JARECKI CHEMICAL CO., THE, SANDUSKY, O. (*concluded*)						
Number One Formula		G*	0.82	9	——	1
Newfane	6619	F*	0.88	8.46	10.32	0.92
Raw Bone and Phosphate Mixture		G	1.65	8	16	1
Bergen	01851	F	1.59	9.49	15.41	1.20
LAWN & FLOWER FERTILIZER CO., RICHMOND, VA.						
Odorless Fertilo		G	5.35	6.50	——	1.25
Nunda	0757	F	4.96	5.59	6.32	1.10
LISTER'S AGRICULTURAL CHEMICAL WORKS, NEWARK, N. J.						
Ground Untreated Phosphate Rock		G	——	——	31.12	——
Red Creek	0796	F	——	——	29.52	——
Lister's Atlas Brand Fertilizer 1916		G	4.11	8	9	——
Elmira	0756	F	3.83	8.55	11.27	——
Lister's Buyer's Choice Acid Phosphate		G	——	14	15	——
Middleport	6611	F	——	14.19	14.89	——
Lister's Celebrated Ground Bone & Tankage Acidulated 1916		G	2.67	——	12	——
Altamont	5348	F	2.88	——	13.48	——
Lister's Corn and Potato Fertilizer 1916		G	2.06	8	9	1
Utica	6733	F	2.07	7.62	9.28	0.90
Lister's Crescent Ammoniated Superphosphate		G	1.65	10	11	——
Utica	6732	F	1.70	10.15	11.89	——
Lister's Excelsior Guano		G	2.47	10	11	——
Utica	6730	F	2.55	10.57	12.99	——
Lister's G Brand 1916		G	4.94	8	9	——
Riverhead	0978	F	5.21	7.64	9.58	——

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
LISTER'S AGRICULTURAL CHEMICAL WORKS, NEWARK, N. J. (*continued*)						
Lister's High Grade Acid Phosphate		G*	——	16	17	——
Middleport	6612	F*	——	15.70	16.50	——
Lister's High Grade Top Dresser		G	8.23	5	6	1
Lima	0790	F	8.61	4.90	6.70	0.93
Lister's New York Special Fertilizer 1916		G	1.65	9	10	1
Bergen	01854	F	1.78	9.35	10.67	1
Lister's Oneida Special 1916		G	0.82	8	9	1
Jamaica	01725	F	0.95	8.56	9.50	1.04
Lister's Perfect Potato Manure 1916		G	3.29	9	10	1
Margaretville	01666	F	3.41	9.12	10.28	0.99
Lister's Plant Food		G	0.82	10	11	——
Utica	6728	F	0.84	10.17	11.31	——
Lister's Potato and Corn No. 2 Fertilizer 1916		G	2.06	10	11	1
Pulaski	6877	F	2.42	10.15	11.99	0.98
Lister's Potato Manure 1916		G	4.11	8	9	1
Huntington	0968	F	4.21	9.30	10.18	0.98
Lister's Special Crop Producer 1916		G	0.82	8	9	1
Bergen	01855	F	1.00	9.10	9.80	1.10
Lister's Standard Pure Superphosphate of Lime 1916		G	2.47	9	10	1
Seneca Falls	01327	F	2.38	9.96	11.10	1.06
Lister's Success Fertilizer		G	1.23	9	10	2
Attica	6693	F	1.31	9.07	10.87	2.30
Lister's Superior Ammoniated Superphosphate		G	3.29	10	11	——
Utica	6729	F	3.35	9.57	11.93	——
Lister's Valley Brand Fertilizer 1916		G	0.82	10	11	1
Spencerport	0171	F	0.94	11.01	11.99	0.97

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
LISTER'S AGRICULTURAL CHEMICAL WORKS, NEWARK, N. J. (*concluded*)						
Lister's Vegetable Compound 1916		G*	4.11	8	9	1
Huntington	0969	F*	4.16	8.58	9.40	1.20
Lister's Wheat and Rye Fertilizer 1916		G	1.65	10	11	1
Pulteney	0794	F	1.65	10.48	11.18	1.03
LOWELL FERTILIZER CO., BOSTON, MASS.						
Acid Phosphate		G	——	16	——	——
Middle Granville	01921	F	——	15.81	16.15	——
Lowell Animal Brand		G	2.87	10	11	——
Oneonta	0330	F	2.83	9.82	10.56	——
Lowell Bone Fertilizer		G	2.05	10	11	——
Hooper	01168	F	2.07	10.80	11.58	——
Lowell Corn & Vegetable		G	4.10	10	11	——
Groton	01331	F	4.08	10.66	11	——
Lowell Dissolved Bone Fertilizer		G	1.64	10	11	——
Brewerton	01276	F	1.71	10.22	10.66	——
Lowell Empress Brand		G	1.25	10	11	——
Copenhagen	6864	F	1.27	9.90	10.08	——
Lowell Market Garden Special Grass & Lawn Dressing		G	4.92	8	9	——
Waterloo	01305	F	4.89	8.56	9.02	——
Lowell Potato & Vegetable		G	4.10	10	11	——
Basom	01061	F	4.09	10.25	10.75	——
Lowell Potato & Vegetable		G	4.10	10	11	——
McLean	01320	F	4.08	9.98	11.16	——
Lowell Potato and Vegetable		G	4.10	10	11	——
Downsville	01661	F	4.26	9.68	10.74	——
Lowell Potato Manure		G	2.46	10	11	——
Brewerton	01277	F	2.56	10.08	11.36	——

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer: Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
LOWELL FERTILIZER CO., BOSTON, MASS. (*concluded*)						
Lowell Potato Phosphate 4-10		G*	3.28	10	11	——
Oneonta	0331	F*	3.02	9.17	9.71	——
Lowell Sterling Phosphate		G	0.82	12	13	——
Copenhagen	6865	F	0.88	11.92	12.08	——
Lowell Sterling Phosphate		G	0.82	12	13	——
Downsville	01660	F	0.87	11.99	12.37	——
LUDLAM COMPANY, FREDERICK, NEW YORK, N. Y.						
Ludlam's Palmetto Fertilizer 1916		G	0.82	8	9	1
Salem	01917	F	0.96	8.81	10.55	0.81
Ludlam's Sickle Fertilizer No. 2—1916		G	1.65	10	11	——
Salem	01916	F	1.92	10.13	11.43	——
Ludlam's Sickle Fertilizer No. 4—1916		G	3.29	10	11	——
Aquebogue	0977	F	3.36	9.80	11.14	——
Ludlam's Sickle Fertilizer No. 5—1916		G	4.11	8	9	——
New Hyde Park	01729	F	4.20	8.20	9.38	——
MCCOY, GEORGE E., PEEKSKILL, N. Y.						
An Honest Fertilizer		G	5	——	16	——
Peekskill	0490	F	5.70	——	17.34	——
MAPES FORMULA & PERUVIAN GUANO CO., THE, NEW YORK, N. Y.						
Mapes Cereal Brand (War Special)		G	2.47	6	8	——
Mt. Kisco	01963	F	2.96	6.32	9.06	——
Mapes Potato Manure War Brand		G	3.71	8	——	1
Mt. Kisco	01962	F	3.82	9.32	10.58	1.12
The Mapes Corn Manure War Brand		G	2.47	8	10	1
Baldwinsville	01267	F	2.53	9.24	11.40	1

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
MAPES FORMULA & PERUVIAN GUANO CO., THE, NEW YORK, N. Y. (*concluded*)						
The Mapes General Crop War Special		G*	1.65	8	10	——
Mt. Kisco	01961	F*	2.00	7.68	11.34	——
The Mapes General Special War Brand		G	5.76	6	8	1
Irvington	01967	F	6.21	7.97	9.67	1.45
The Mapes Tobacco Starter Improved		G	4.12	6	8	1
Baldwinsville	01266	F	4.39	6.15	9.21	1.23
The Mapes Tobacco Starter Improved		G	4.12	6	8	1
Owego	01236	F	4.42	6.57	9.39	1.14
The Mapes Top Dresser Half Strength War Brand		G	4.94	2.50	4	0.50
Irvington	01966	F	4.92	3.38	4.52	1.20
MARTIN FERTILIZER CO., PHILADELPHIA, PA.						
Acid Phosphate 14%		G	——	14	——	——
Syracuse	01291	F	——	16	16.42	——
Three Eight		G	2.46	8	——	——
Syracuse	01292	F	2.50	9.22	12.82	——
Four Eight		G	3.28	8	——	——
Syracuse	01287	F	3.31	8.70	10.08	——
Four Ten		G	3.29	10	——	——
Syracuse	01293	F	2.96	11.33	12.91	——
MILLER FERTILIZER CO., THE, BALTIMORE, MD.						
Ground Bone		G	2.47	——	14.50	——
Olean	6621	F	2.17	——	11.60	——

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
MINERAL FERTILIZER CO., THE, CHICAGO, ILL.						
Nu-Life Fertilizer		G*	——	——	15	——
Rochester	0159	F*	——	——	13.74	——
NASSAU FERTILIZER CO., NEW YORK, N. Y.						
Ammoniated Truck Producer		G	3.29	10	11	——
Glens Falls	01907	F	3.23	10.37	11.17	——
Common Sense Fertilizer 1916		G	1.65	10	11	——
Glens Falls	01908	F	1.79	10.40	11.32	——
High Grade Superphosphate		G	——	16	17	——
Camden	6741	F	——	15.86	16.54	——
Old Hickory 1916		G	0.82	10	11	——
Candor	01214	F	1.03	10.35	11.19	——
Potato Manure 1916		G	2.06	8	9	1
Candor	01215	F	2.14	8.79	10.47	1
Soluble Phosphate		G	——	14	15	——
Candor	01213	F	——	14.35	15.13	——
NATIONAL FERTILIZER CO., THE, NEW YORK, N. Y.						
National Complete Root & Grain Fertilizer 1916		G	3.29	8	9	4
Hicksville	01750	F	3.31	8.18	9.50	4.27
National Nitrogen Phosphate Mixture No. 5		G	4.11	8	9	——
Hicksville	01749	F	4.15	8.62	9.68	——
NATIONAL GUANO CO., AURORA, ILL.						
Pulverized Sheep Manure		G	2.25	1	1.25	1.50
Jamestown	01892	F	2.60	1.87	2.07	1.59
Sheep's Head Brand Pulverized Sheep Manure		G	2.25	1	1.25	1.50
Syracuse	01252	F	2.52	1.23	1.35	1.96

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
NEWBURGH RENDERING CO., NEWBURGH, N. Y.						
Concentrated Tankage		G*	11	——	——	——
Newburgh	0488	F*	11.40	——	——	——
Pure Meat and Bone Fertilizer		G	4	——	16	——
Newburgh	0489	F	5.60	——	15.41	——
NEWHOF & SON, L., ALBANY, N. Y.						
Pure Fertilizer		G	5	——	9	——
Albany	5324	F	5.01	——	11.21	——
NEW YORK STABLE MANURE CO., JERSEY CITY, N. J.						
Diamond Brand Dried Ground Compost		G	2.06	1.50	1.79	——
Freeport	P 207	F	2.62	2.17	2.37	1.70
NEW YORK STATE GRANGE PURCHASING AGENCY, OLEAN, N. Y.						
Bone Meal		G	——	——	——	——
Sanborn	01062	F	——	15.14	16.76	——
Dried Blood		G	——	——	——	——
Atlanta	0762	F	5.49	——	——	——
Nitrate Soda		G	——	——	——	——
Atlanta	0761	F	11.20	——	——	——
Patron's ½-11-½		G	0.41	11	11.50	0.50
Atlanta	0764	F	0.48	11.23	13.91	0.27
Patron's 1-8-1		G	0.82	8	8.50	1
Atlanta	0765	F	1.16	9.12	11.70	0.94
Patron's 1-8-1		G	0.82	8	8.50	1
South Lansing	01191	F	0.81	8.63	11.05	0.64
Patron's 1-8-1		G	0.82	8	8.50	1
Moravia	01315	F	1.01	8.70	11.16	0.74
Patron's 2-8-2		G	1.64	8	8.50	2
Esperance	0323	F	2.07	7.77	9.02	1.61

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REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
NEW YORK STATE GRANGE PURCHASING AGENCY, OLEAN, N. Y. (*continued*)						
Patron's 2-8-2		G*	1.64	8	8.50	2
Atlanta	0766	F*	1.41	8.27	10.86	1.59
Patron's 2-8-2		G	1.64	8	8.50	2
South Lansing	01192	F	1.62	8.88	11.22	1.42
Patron's 2-8-2		G	1.64	8	8.50	2
Ithaca	01330	F	1.46	8.26	10.58	1.42
Patron's 2-8-2		G	1.64	8	8.50	2
Salem	01919	F	1.54	8.02	11.06	1.27
Patron's 2-9-1.50		G	1.64	9	9.50	1.50
New Berlin	01230	F	1.52	9.98	11.06	1.06
Patron's 2-9-1.50		G	1.64	9	9.50	1.50
Moravia	01316	F	1.51	9.13	11.50	1.21
Patron's 2-9-1.50		G	1.64	9	9.50	1.50
Salem	01920	F	1.50	9.60	11.88	1.15
Patron's 3-8-2		G	2.46	8	8.50	2
Atlanta	0763	F	1.98	7.88	11.62	1.28
Patron's 14% Acid Phosphate		G	——	14	14.50	——
Esperance	0325	F	——	14.51	15.49	——
Patron's 14% Acid Phosphate		G	——	14	14.50	——
Lodi	01334	F	——	14.16	14.62	——
16% Acid Phosphate		G	——	16	16.30	——
Esperance	0324	F	——	15.70	16.60	——
16% Acid Phosphate		G	——	16	16.50	——
Atlanta	0767	F	——	14.71	16.60	——
16% Acid Phosphate		G	——	16	16.50	——
Sanborn	01063	F	——	15.23	17.34	——
Patron's 16% Acid Phosphate		G	——	16	16.50	——
New Berlin	01231	F	——	15.84	16.40	——

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
NEW YORK STATE GRANGE PURCHASING AGENCY, OLEAN, N. Y. (*concluded*)						
Patron's 16% Acid Phosphate		G*	——	16	16.50	——
Moravia	01314	F*	——	14.83	15.23	——
Patron's 16% Acid Phosphate		G	——	16	16.50	——
Perry	01867	F	——	15.31	15.87	——
NITRATE AGENCIES CO., NEW YORK, N. Y.						
Dried Blood		G	13.16	——	——	——
Brooklyn	0998	F	13.05	——	——	——
Fertilizer mixed by request		G	——	——	——	——
East Marion	0987	F	5.63	11.76	12.86	1.30
Ground Bone		G	2.46	——	22.88	——
Old Northport	P 203	F	2.54	——	22.62	——
Ground Tankage		G	5.75	——	6.86	——
Cutchogue	0983	F	5.77	——	11.08	——
High Grade Acid Phosphate		G	——	16	——	——
Cutchogue	0986	F	——	15.22	15.42	——
High Grade Chemical Fertilizer (Devlin Formula)		G	4.93	8	——	4
Brooklyn	01000	F	6.04	9.76	10.73	3.50
High Grade Genuine Peruvian Guano		G	10.69	10.	11	2.50
Southampton	0993	F	10.69	11.23	12.15	2.65
Nitrate of Soda		G	15	——	——	——
Cutchogue	0985	F	15.59	——	——	——
Pescadore's High Grade Genuine Peruvian Guano		G	11.51	10	13	2.50
Cutchogue	0984	F	11.54	11.42	12.04	2.84
PATAPSCO GUANO CO., BALTIMORE, MD.						
Coon Brand Guano 1916		G	0.82	10	11	1
Port Leyden	6853	F	0.95	10.82	11.92	1.02

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER: Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
PATAPSCO GUANO CO., BALTIMORE, MD. (*concluded*)						
Grange Mixture 1916		G*	1.65	9	10	1
North Norwich	01195	F*	1.82	9.89	11.16	0.82
Patapsco Ammoniated Compound		G	0.82	10	11	——
Bridgewater	6734	F	0.90	10.76	11.78	——
Patapsco Columbian Guano for Truck Potatoes & Tobacco 1916		G	2.47	9	10	1
North Norwich	01196	F	2.50	10.12	10.78	0.86
Patapsco Corn and Tomato Fertiliser 1916		G	1.23	10	11	1
Lyons Falls	6856	F	1.38	10.38	11.42	1.06
Patapsco Golden Crop Fertiliser 1916		G	1.65	10	11	——
Bridgewater	6735	F	1.70	10.59	12.03	——
Patapsco Golden Crop Fertiliser 1916		G	1.65	10	11	——
South New Berlin	01161	F	1.69	10.54	11.80	——
Patapsco High Grade Acid Phosphate		G	——	16	17	——
Bridgewater	6736	F	——	16.28	16.94	——
Patapsco Money Maker 1916		G	0.82	8	9	1
Oxford	01193	F	0.94	8.69	9.87	1.03
Patapsco Pure Dissolved S. C. Phosphate		G	——	14	15	——
Port Leyden	6852	F	——	14.10	14.94	——
Patapsco Special Potato Manure 1916		G	1.65	10	11	1
South New Berlin	01162	F	1.68	11.26	11.92	0.80
PIEDMONT-MT. AIRY GUANO CO., BALTIMORE, MD.						
Levering's Excelsior		G	0.82	8	——	1
Darien	01056	F	0.84	8.30	8.90	1.02

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid		Potash
				Available	Total	
PIEDMONT-MT. AIRY GUANO CO., BALTIMORE, MD. (*concluded*)						
Levering's Excelsior		G*	0.82	8	——	1
Skaneateles	01298	F*	0.95	8.21	8.74	1.01
Nitrate of Soda		G	15.73	——	——	——
North Rose	0798	F	15.74	——	——	——
Piedmont Blue Ribbon Fertilizer		G	2.47	10	——	——
Darien	01055	F	2.33	10.02	10.72	——
Piedmont 12 Per Cent Acid Phosphate		G	——	12	——	——
Skaneateles	01299	F	——	12.18	12.38	——
Piedmont 14 Per Cent Acid Phosphate		G	——	14	——	——
Byron	01861	F	——	14.98	15.08	——
Piedmont 16 Per Cent Acid Phosphate		G	——	16	——	——
Darien	01057	F	——	16.27	16.42	——
Piedmont Special Crop Grower		G	0.82	10	——	——
Brewerton	01279	F	0.84	10.44	10.92	——
Piedmont Utility Fertilizer		G	1.65	10	——	——
Brewerton	01278	F	1.66	10.20	10.86	——
PINE & SON, B. J., EAST WILLISTON, N. Y.						
Pine's No. 2 Star Raw Bone Superphosphate Revised		G	2.06	8	9	1
New Hyde Park	01733	F	2.20	8.28	10.08	0.86
PULVERIZED MANURE CO., THE, CHICAGO, ILL.						
Wizard Brand Manure		G	1.80	1	——	1
Rochester	0158	F	2.00	1.24	——	2.74
RASIN MONUMENTAL CO., BALTIMORE, MD.						
Nitrate of Soda		G	14.82	——	——	——
Fruitland	0787	F	15.16	——	——	——

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer: Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
RASIN MONUMENTAL CO., BALTIMORE, MD. (*continued*)						
Rasin's 12% Acid Phosphate		G*	——	12	13	——
Merrifield	01326	F*	——	12.16	13.38	——
Rasin's Acid Phosphate		G	——	14	15	——
Amsterdam	5338	F	——	15.22	16.08	——
Rasin's Sixteen Per Cent Acid Phosphate		G	——	16	17	——
Amsterdam	5337	F	——	16.70	17.52	——
Rasin's Capital Crop Compound Revised		G	0.82	9	10	1
Oran	01282	F	0.88	10.08	11.94	0.97
Rasin's Emergency Royal Fish Bone & Potash		G	1.65	8.50	9.50	1
Cohocton	0752	F	1.70	9.27	11.31	1.05
Rasin's Empire Ammoniated Super-phosphate		G	2.47	10	11	——
Collins	01886	F	2.58	9.47	10.97	——
Rasin's Empire Guano		G	1.65	8	9	2
Amsterdam	5339	F	1.67	9.16	10.34	1.65
Rasin's Empire Guano Special Revised		G	2.47	8	9	2
Fulton	6871	F	2.26	7.66	8.64	2.42
Rasin's Grain & Grass Ammoniated Superphosphate		G	0.82	12	13	——
Cohocton	0751	F	0.96	12.79	13.74	——
Rasin's Matchless Ammoniated Phosphate		G	1.65	12	13	——
Amsterdam	5341	F	1.74	12.92	14.42	——
Rasin's Potato & Vegetable Ammoniated Super Phosphate		G	3.29	8	9	——
Wolcott	0797	F	3.65	7.34	9.97	——

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
RASIN MONUMENTAL CO., BALTIMORE, MD. (*concluded*)						
Rasin's Sea Wall Special		G*	——	10	11	——
Voorheesville	5343	F*	——	11.33	12.39	——
Rasin's Special Crop Preparation		G	1.65	10	11	——
Amsterdam	5340	F	1.77	10.26	11.36	——
Rasin's Special Fish & Bone Guano		G	1.65	11	12	——
Merrifield	01325	F	1.68	11.28	12.80	——
Rasin's Truck Ammoniated Super Phosphate		G	4.12	8	9	——
Fairport	0784	F	4.04	8.80	9.60	——
Rasin's United Grain Ammoniated Superphosphate		G	1.03	10	11	——
Voorheesville	5344	F	1.13	10.01	11.05	——
William Penn Crop Grower		G	0.82	8	9	1
Voorheesville	5345	F	0.93	8.27	9.91	1.28
READING BONE FERTILIZER CO., READING, PA.						
Animal Tankage Mixture		G	1.64	14	15	——
Hamburg	01873	F	1.82	13.59	16.76	——
Dissolved Animal Matter		G	0.82	10	11	——
Hamburg	01872	F	1.03	11.14	12.38	——
Reading All Crop Special		G	1.64	10	11	——
Hamburg	01874	F	1.77	9.15	11.16	——
Reading's Soil Enricher		G	2.46	12	13	——
Hoosick Falls	01927	F	2.50	10.86	13.16	——
ROGERS & HUBBARD CO., THE, PORTLAND, CONN.						
Hubbard Bone Base Oats & Top Dressing		G	6	6	12	——
Berlin	01931	F	6.36	7.74	14.68	——

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer: Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
ROGERS & HUBBARD CO., THE, PORTLAND, CONN. (*concluded*)						
Hubbard Bone Base Soluble Corn and General Crop Manure		G*	2.50	10	12	——
Granville	01922	F*	2.60	8.61	13.27	——
Rogers & Hubbard Complete Phosphate		G	——	——	——	——
Granville	01923	F	1.22	8.67	11.43	——
F. S. ROYSTER GUANO CO., BALTIMORE, MD.						
Nitrate of Soda		G	15	——	——	——
Williamson	0190	F	15.56	——	——	——
Royster's Cuckoo Crop Grower		G	0.82	8	8.50	1
Poland	6718	F	1.14	8.28	9.06	1.06
Royster's Curfew Ammoniated Superphosphate		G	3.29	8	8.50	——
Fultonville	5334	F	3.05	8.38	10.52	——
Royster's Defender Fertilizer		G	3.29	8	8.50	1
Delhi	01671	F	2.76	8.51	9.71	1.03
Royster's Dreadnought Fertilizer		G	1.65	8	8.50	2
Ontario	0187	F	1.71	7.88	8.72	2.34
Royster's Drillwell Phosphate		G	2.47	8	8.50	1
Hannibal	6876	F	2.75	7.66	9.14	1.10
Royster's Fine Ground Bone Meal		G	2.47	——	22.90	——
Interlaken	01294	F	2.82	——	22.26	——
Royster's Flamingo Ammoniated Superphosphate		G	2.06	12	12.50	——
Gage	0174	F	2.17	12.18	13.88	——
Royster's 14% Acid Phosphate		G	——	14	14.50	——
Fultonville	5336	F	——	14.09	15.27	——
Royster's Good Will Ammoniated Superphosphate		G	4.11	8	8.50	——
New Hyde Park	01730	F	4.28	8.25	10.61	——

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
F. S. ROYSTER GUANO CO., BALTIMORE, MD. (*concluded*)						
Royster's High Grade 16% Acid Phosphate		G*	——	16	16.50	——
Fultonville	5335	F*	——	16.61	17.07	——
Royster's Innovation Ammoniated Superphosphate		G	2.47	8	8.50	——
Phoenix	6875	F	2.46	8.52	10.06	——
Royster's Logical Compound		G	1.65	8	8.50	1
Crogan	6858	F	1.64	7.93	8.99	1.01
Royster's Old Faithful Phosphate		G	2.06	8	8.50	1
Webster	0185	F	2.11	7.66	9.60	1.04
Royster's Penguin Ammoniated Superphosphate		G	1.65	10	10.50	——
Poland	6720	F	1.68	10.42	12.22	——
Royster's Royal Blue Ammoniated Superphosphate		G	0.82	10	10.50	——
Poland	6719	F	0.94	10.55	12.19	——
SANDER, ADAM, SALAMANCA, N. Y.						
Dry Tankage Fertilizer		G	5.38	6	15.40	——
Salamanca	6620	F	6.87	7.80	12.20	——
SANDERSON FERTILIZER & CHEMICAL CO., NEW HAVEN, CONN.						
Sanderson's Cabbage Fertilizer 1916		G	4.11	8	9	1
Jamaica	01723	F	4.15	9.09	10.63	1.20
Sanderson's Special Potato Manure 1916		G	3.29	9	10	1
Jamaica	01722	F	3.27	9.58	11.26	1.68
SCHAAL-SHELDON FERTILIZER CO., BUFFALO, N. Y.						
Ammoniated Superphosphate No. 1		G	0.82	10	11	——
Randolph	01894	F	0.94	10.26	11.92	——
Ammoniated Superphosphate No. 2		G	1.65	10	11	——
Randolph	01893	F	1.77	9.94	11.78	——

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer: Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
SCHAAL-SHELDON FERTILIZER CO., BUFFALO, N. Y. (*concluded*)						
Ammoniated Superphosphate No. 3		G*	2.47	10	11	——
Warsaw	6695	F*	2.46	9.65	11.62	——
Ammoniated Superphosphate No. 4		G	3.29	10	11	——
Warsaw	6696	F	3.10	10.47	11.45	——
Dissolved Phosphate		G	——	14	15	——
Pavilion	01059	F	——	14.02	15.02	——
Fine Ground Bone		G	2.47	——	22.88	——
Freedom	6624	F	2.74	——	23.30	——
High Grade Dried Blood		G	9.87	——	——	——
Eden Center	01880	F	9.70	——	——	——
Soluble Phosphate		G	——	16	17	——
Warsaw	6694	F	——	16.23	16.92	——
SCHOEMAKER & CO., LTD., M. L., PHILADELPHIA, PA.						
Swift-Sure Bone Meal		G	4.53	——	20	——
Southampton	0995	F	5.18	——	22.72	——
SOUTH SHORE GROWERS & SHIPPERS ASS'N, SILVER CREEK, N. Y.						
South Shore Growers Mixture No. 1		G	3.10	8	9	0.25
Silver Creek	6637	F	3.22	8.16	9.16	0.46
South Shore Growers Mixture No. 2		G	1.85	8	9	0.25
Irving	6641	F	1.30	9.74	10.94	0 66
South Shore Growers Mixture No. 3		G	1.03	9	10	0.25
Silver Creek	6638	F	1.19	10.38	11.66	0.54
STAPPENBECK & SONS, H., UTICA, N. Y.						
Animal Bone		G	2.50	8	15	——
Whitesboro	6727	F	2.98	12.99	18.47	——
Animal Tankage		G	7	——	9	——
Rochester	0172	F	7.73	——	7.90	——

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer: Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
STONEMEAL FERTILIZER CO., NORTH PATTERSON, N. J.						
Stonemeal		G*	——	——	10.12	10.42
Ransomville	6649	F*	——	——	3.38	trace
STUMPP & WALTER CO., NEW YORK, N. Y.						
Emerald Lawn Dressing & General Garden Fertilizer		G	3	5.00	6.00	1
New York	01717	F	3.05	6.12	6.56	1
S & W Co's Bone Fertilizer		G	3	——	20	——
New York	01718	F	3.50	——	19.90	——
SWIFT & COMPANY, BALTIMORE, MD.						
Riverhead Town Agr'l Society Fertilizer 1916 Formula No. 2		G	4.94	8	——	——
Riverhead	0975	F	4.93	7.20	8.87	——
Riverhead Town Agr'l Society Fertilizer 1916 Formula No. 4		G	3.29	8	——	——
Riverhead	0976	F	2.56	7.10	7.38	——
Swift's Pulverized Sheep Manure		G	1.65	——	1	1.50
Amsterdam	5332	F	1.94	——	2.02	2.59
Swift's Pure Ammoniated Bone Phosphate		G	0.82	10	10.50	——
Clyde	0179	F	0.84	10.52	11.04	——
Swift's Pure Ammoniated Bone Phosphate & Potash		G	1.65	10	11	0.50
Frewsburg	01888	F	1.69	10.42	11.94	0.54
Swift's Pure Bone Meal		G	2.47	——	24	——
Williamson	0189	F	2.44	——	23.86	——
Swift's Pure Corn and Wheat Grower		G	1.65	10	——	2
Chatham	0494	F	1.81	11.88	13.48	1.94
Swift's Pure Corn Grower		G	1.65	10	——	1
Chatham	0495	F	1.88	9.50	10.70	1.38

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		Pounds in 100 Pounds of Fertilizer: Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
SWIFT & COMPANY, BALTIMORE, MD. (*continued*)						
Swift's Pure Diamond A Potato Fertilizer		G*	2.47	8	9	1
Salamanca	01895	F*	2.43	8.34	9.86	0.96
Swift's Pure Diamond B Fertilizer		G	1.65	8	8	——
Ellenville	01651	F	2.00	9.80	10.36	——
Swift's Pure Diamond C Grain Fertilizer		G	0.82	8	——	——
Ellenville	01653	F	0.81	7.50	8.38	——
Swift's Pure Diamond K Grain Grower		G	0.82	12	12.50	1
Eden Center	01879	F	0.84	11.99	12.63	1.06
Swift's Pure Farmers Favorite Fertilizer		G	1.65	9		1
Chatham	0497	F	1.87	9.32	10.50	1.26
Swift's Pure Garden & Truck Fertilizer		G	3.29	8	9	1
Kennedy	6631	F	3.36	8.10	9.86	0.69
Swift's Pure Garden City Phosphate		G	——	14		——
Fulton	6870	F	——	14.54	15.52	——
Swift's Pure High Grade Acid Phosphate		G	——	16		——
Cortland	01180	F	——	15.88	17.02	——
Swift's Pure Long Island Favorite		G	4.11	10		——
Mineola	01741	F	4.16	10.36	11.22	——
Swift's Pure Pulverized Sheep Manure		G	2.06	——	1.50	1.50
Delhi	6210	F	1.80	——	1.58	2.43
Swift's Pure Pulverized Sheep Manure		G	1.65	——	1	1.50
Delhi	6211	F	2.32	——	1.84	2.94

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer: Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
SWIFT & COMPANY, BALTIMORE, MD. (*continued*)						
Swift's Pure Red Steer		G*	1.65	8	——	——
Cortland	01178	F*	1.75	7.84	8.92	——
Swift's Pure Reliable Grain Fertilizer		G	0.82	8	——	1
Cortland	01179	F	1.02	7.67	8.64	1.13
Swift's Pure Soluble Phosphate		G	——	12	——	——
Cambridge	01925	F	——	11.69	12.47	——
Swift's Pure Special Baltimore Formula		G	3.29	10	——	——
Tully	01289	F	2.98	9.90	11.34	——
Swift's Pure Special Corn Grower		G	1.65	10	——	——
Cortland	01174	F	1.88	9.33	10.55	——
Swift's Pure Special Diamond A		G	2.47	8	——	——
Candor	01216	F	2.98	7.15	8.02	——
Swift's Pure Special Formula A		G	3.29	8	——	——
Cortland	01173	F	3.31	7.51	8.03	——
Swift's Pure Special Formula A		G	3.29	8	——	——
Tully	01290	F	3.42	9.59	10.53	——
Swift's Pure Special Formula A		G	3.29	8	——	——
Mineola	01742	F	3.23	8.60	9.10	——
Swift's Pure Special Formula C		G	1.65	12	——	——
Benton	0198	F	1.69	10.73	11.77	——
Swift's Pure Special Formula D		G	0.82	9	——	——
Cortland	01176	F	0.85	8.36	9.10	——
Swift's Pure Special Grain Grower		G	1.65	12	——	1
Cambridge	01924	F	1.55	11.96	13.16	0.80
Swift's Pure Special Harrison Formula Fertilizer		G	3.29	10	——	——
Albany	01934	F	3.88	9.54	10.92	——

* These letters indicate, respectively, Guaranteed and Found.

Report of Analyses of Samples of Fertilizers Collected by the Commissioner of Agriculture During 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
Swift & Company, Baltimore, Md. (*concluded*)						
Swift's Pure Special Long Island Fertilizer		G*	4.94	8	——	——
Old Northport	P202	F*	4.74	8	9.12	——
Swift's Pure Special Pride of Jersey		G	4.11	8	——	——
Poughkeepsie	01974	F	4.14	6.58	9.03	——
Swift's Pure Superphosphate		G	1.65	8	9	2
Webster	0184	F	1.64	8.18	9.54	2
Swift's Pure Top Dressing Formula No. 1		G	5.76	8	——	——
White Plains	01972	F	5.30	9.03	9.71	——
Swift's Pure Truck & Potato Fertilizer		G	3.29	8	——	——
White Plains	01971	F	3.56	8.71	9.51	——
Swift's Pure Truck & Vegetable		G	1.65	8	——	1
Cortland	01175	F	1.65	8.14	8.92	0.97
Swift's Tankage		G	8.23	——	——	——
Arkport	0760	F	8.32	——	——	——
Syracuse Rendering Co., Syracuse, N. Y.						
Syracuse Animal Brand A Fertilizer for All Crops		G	2.46	11	12	——
Clyde	0177	F	2.86	11.26	12.02	——
Syracuse Bone Meal		G	3.28	5	23	——
Syracuse	01251	F	3.40	11.04	21.56	——
Syracuse 4-8-1		G	3.28	8	9	1
Syracuse	01262	F	3.25	9.06	9.56	1.02
Syracuse Ground Bone		G	2.46	——	23	——
Syracuse	01265	F	2.54	——	23.18	——
Syracuse High Grade Acid Phosphate		G	——	16	16.50	——
Groton	01317	F	——	16.62	16.76	——

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid Available	Phosphoric acid Total	Potash
SYRACUSE RENDERING CO., SYRACUSE, N. Y. (*concluded*)						
Syracuse Indian Brand for Corn and Wheat		G*	2.05	10	11	——
Waterville	6739	F*	2.03	9.79	11.73	——
Syracuse Market Garden Manure		G	3.28	11	12	——
Clyde	0176	F	3.41	11.36	12.62	——
Syracuse Onondaga Brand		G	1.24	10	11	——
Syracuse	01264	F	1.43	10.39	10.96	——
Syracuse Onondaga Brand Containing 9% Available Phos. Acid		G	1.24	9	10	——
North Greece	0782	F	1.45	8.73	10.25	——
Syracuse Potato Manure for Potatoes & Celery		G	2.87	10	11	——
Owego	01212	F	2.90	10.76	11.42	——
Syracuse Seneca Brand		G	1.64	9	10	——
Syracuse	01263	F	1.74	10.22	11.20	——
Syracuse Special for Cabbage, Onions and Potatoes		G	2.05	11	12	——
Syracuse	01272	F	2.15	11.89	12.31	——
Syracuse Superphosphate for Oats & Buckwheat		G	0.82	11	12	——
Waterville	6740	F	0.94	11.74	12.04	——
Syracuse Vegetable Grower		G	4.10	10	11	——
Clyde	0178	F	4.12	10.58	10.92	——
TENNESSEE COAL, IRON & R. R. CO., BIRMINGHAM, ALA.						
Duplex Basic Phosphate A A		G	——	——	18	——
Brooklyn	0999	F	——	——	18.48	——
THOMAS & SON CO., I. P., PHILADELPHIA, PA.						
Fish Guano		G	4.10	10	10.50	——
Yaphank	0970	F	3.45	10.59	12.03	——

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
THOMAS & SON CO., I. P., PHILADELPHIA, PA. (*concluded*)						
Long Island Special		G*	3.25	10	10.50	——
Hicksville	01743	F*	3.31	10.96	12.60	——
Tip-Top Fertilizer		G	2.45	8	8.50	1
Westhampton Beach	0992	F	2.90	9.45	10.97	1.39
Truckers High Grade Manure		G	3.25	8	8.50	1
Westhampton Beach	0991	F	3.12	8.57	9.87	1.06
THOMSON & SONS, LTD., WM., CLOVENFORDS, SCOTLAND						
Genuine Scotch Soot		G	4	——	——	——
New York	01714	F	3.69	——	——	——
Thomson's Special Chrysanthemum Manure		G	4.25	7	10.50	1.50
New York	01716	F	4.84	12.98	13.20	1.92
Thomson's Vine, Plant and Vegetable Manure		G	3.25	8	11.50	1.50
New York	01715	F	3.85	10.06	12.44	3.56
THORBURN & CO., J. M., NEW YORK, N. Y.						
Thorburn's Complete Manure		G	1.65	9	10	1
New York	0957	F	1.67	10	11.16	0.88
Thorburn's Lawn Fertilizer		G	4.11	8	9	1
New York	0956	F	4.13	8.51	9.73	1.26
Thorburn's Potato Manure		G	3.29	9	10	1
New York	0958	F	3.22	9.97	10.79	0.99
TUNNELL & CO., INC., F. W., PHILADELPHIA, PA.						
Acid Fish and Tankage		G	4.12	——	6	——
Good Ground	0997	F	3.31	——	6.81	——
F. W. Tunnell & Co.'s American Trucker		G	4.94	8	9	——
Riverhead	0962	F	4.56	9.14	11.14	——

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer: Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
TUNNELL & CO., INC., F. W., PHILADELPHIA, PA. (*concluded*)						
F. W. Tunnell & Co.'s 1916 10% Guano		G*	8.25	4	5	——
Riverhead	0963	F*	7.18	5.94	6.68	——
1916 Lightning Guano		G	4.12	8	9	——
Hicksville	0954	F	3.86	9.06	10.50	——
Long Island Trucker		G	4.12	10	11	——
Riverhead	0961	F	3.79	8.43	10.64	——
No. 1 Potato & Truck Manure 1916		G	3.30	10	11	——
Hicksville	0955	F	3.42	10.12	11.98	——
TUSCARORA FERTILIZER CO., BALTIMORE, MD.						
Tuscarora 2-11-0		G	1.65	11	11.50	——
Apulia	01241	F	1.77	11.19	12.00	——
UNITED FERTILIZER CO., CHICAGO, ILL.						
Evergreen Brand Flower and Lawn Fertilizer		G	8	14.50	——	15
Buffalo	6642	F	8.14	15.75	16.77	16.05
VAN IDERSTINE CO., THE, LONG ISLAND CITY, N. Y.						
Van Iderstine's Pure Ground Bone		G	2	——	27	——
L. I. City	01736	F	2.05	——	26.87	——
VAUGHAN SEED STORE, NEW YORK, N. Y.						
Ichthemic Guano		G	——	——	——	——
Ardsley	01721	F	3.60	7.10	7.52	1.20
Vaughan's Bone Flour		G	3.70	——	22	——
New York	01713	F	4.39	——	24.91	——
Vaughan's Lawn & Garden		G	2.47	8	——	3
New York	01712	F	2.49	8.94	10.02	3.32
Vaughan's Rams Head Brand Pulverized Sheep Manure		G	2	1	1.20	1
New York	01710	F	2.08	1.09	1.13	2.04

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		POUNDS IN 100 POUNDS OF FERTILIZER			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
VAUGHAN SEED STORE, NEW YORK, N. Y. (*concluded*)						
Vaughan's Rose Grower Bone Meal		G*	3.70	——	22.25	——
New York	01711	F*	3.76	——	20.78	——
VIRGINIA-CAROLINA CHEMICAL CO., NEW YORK, N. Y.						
V-C. C. Co.'s Ammoniated Bone Phosphate for All Crops		G	1.65	10	11	——
Phelps	0169	F	1.75	9.42	11	——
V-C. C. Co.'s Ammoniated Bone Phosphate for All Crops		G	1.65	10	11	——
Syracuse	01269	F	1.85	11.29	12.45	——
V.-C. C. Co.'s Beef Blood & Bone B.B.B. Without Potash		G	3.29	10	11	——
Cortland	01181	F	3.06	10.84	12.56	——
V-C. C. Co.'s Beef Blood & Bone B.B.B. With 2% Potash		G	3.29	8	9	2
Holcomb	0793	F	3.24	9.49	11.01	2.22
V-C. C. Co.'s High Grade Acid Phosphate		G	——	16	17	——
Marathon	01164	F	——	16.98	17.18	——
V-C. C. Co.'s High Grade Ammoniated Bone Phosphate		G	1.65	12	13	——
Marathon	01165	F	1.72	12.82	14.06	——
V-C. C. Co.'s High Grade Corn & Vegetable Compound without Potash		G	2.47	10	11	——
Cortland	01182	F	2.43	9.66	11.76	——
V-C. C. Co.'s High Grade Corn & Vegetable Compound with 1% Potash		G	2.47	8	9	1
Mt. Kisco	01959	F	2.46	8.96	10.28	1.16
V-C. C. Co.'s Owl Brand Potato Fertiliser		G	1.65	8	9	1
Plattsburg	5274	F	1.65	8.48	10.54	1.11

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

Name and Address of Manufacturer or Jobber; Brand or Trade Name; and Locality Where Sample was Taken	Number		Pounds in 100 Pounds of Fertilizer			
			Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
VIRGINIA-CAROLINA CHEMICAL CO., NEW YORK, N. Y. (*concluded*)						
V-C. C. Co.'s Plow Brand Fertilizer		G*	0.82	8	9	1
Lowville	6861	F*	0.87	9.31	10.15	1.02
V-C. C. Co.'s Red Cross 14% Acid Phosphate		G	——	14	15	——
Syracuse	01268	F	——	13.62	13.86	——
V-C. C. Co.'s Tip Top Dresser with 1% Potash		G	5.76	5	6	1
Mt. Kisco	01957	F	5.30	7.40	8.88	1.40
V-C. C. Co.'s 20th Century Potato Manure without Potash		G	4.12	10	11	——
Phelps	0170	F	4.05	10.98	13.18	——
V-C. C. Co.'s 20th Century Potato Manure with 2% Potash		G	4.12	8	9	2
Mt. Kisco	01960	F	4.32	8.78	10.14	2.33
V-C. C. Co.'s Universal Fertilizer for All Crops without Potash		G	0.82	9	10	——
Elba	01058	F	0.98	9.02	10.14	——
WALLACEBURG COOPERAGE CO., WALLACEBURG, ONTARIO						
Wood Ashes		G	——	——	——	——
Linwood	6681	F	——	——	1.36	4.10
WEEBER & DON, NEW YORK, N. Y.						
Weeber & Don's Lawn and Garden Fertilizer		G	1.65	8	10	——
New York	01720	F	1.98	7.84	11.49	——
WHANN CO., W. E., PHILADELPHIA, PA.						
Whann's Chester Valley Non Potash Fertilizer No. 5		G	4.11	8	9	——
Riverhead	0964	F	4.17	8.22	9.62	——
WILCOX FERTILIZER CO., THE, MYSTIC, CONN.						
Wilcox Corn Special		G	3.30	10	11	——
Yaphank	0971	F	3.34	8.91	12.04	——

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*contiuned*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		Pounds in 100 Pounds of Fertilizer: Nitrogen	Phosphoric acid: Available	Phosphoric acid: Total	Potash
WILCOX FERTILIZER CO., THE, MYSTIC, CONN. (*concluded*)						
Wilcox Fish & Potash		G*	2.40	8	9	0.50
Manorville	0974	F*	2.58	8.85	9.37	0.41
Wilcox Long Island Dry Ground Fish		G	8.24	5	6	——
Orient	0988	F	8.72	5.04	6.76	——
Wilcox Potato & Vegetable Fertilizer		G	4.12	8	9	——
Manorville	0973	F	4.45	8.26	9.98	——
WITHERBEE, SHERMAN & CO., INC., PORT HENRY, N. Y.						
Barium-Phosphate		G	——	——	14	——
Port Henry	01909	F	——	——	15.54	——

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

LIME COMPOUNDS.

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		Calcium oxide	Magnesium oxide
AMERICAN LIME & STONE CO., TYRONE, PA.		G*	66.75	——
Hydra-Oxide of Lime				
Canisteo	0759	F*	68.07	0.91
BLAIR LIMESTONE CO., MARTINSBURG, W. VA.				
Opegnon Hydrated Lime		G	65	——
Maine	01211	F	65.50	1.44
CONLEY LIME & FERTILIZER CO., F. E., UTICA, N. Y.				
Raw Ground Lime		G	51.50	——
Oxford	01194	F	51.84	1.24
DUTCHESS COUNTY LIME CO., DOVER PLAINS, N. Y.				
Ground Oxide		G	58	——
Dover Plains	01952	F	51.58	34.00
Hydra-Oxide		G	45	——
Dover Plains	0500	F	45.85	30.83
EDISON PULVERIZED LIME STONE CO., STEWARTSVILLE, N. J.				
Edison Pulverized Lime Stone		G	50	——
Cambridge	01926	F	49.60	1.83
EMPIRE GYPSUM CO., GARBUTT, N. Y.				
Empire Land Plaster		G	——	——
Fort Ann	01912	F	31.08	3.82
FARNAM CHESHIRE LIME CO., FARNAMS, MASS.				
Farnam Cheshire Lime Co.'s Agricultural Lime		G	60	——
Claverack	01994	F	60.51	0.61
GENESEE LIME CO., HONEOYE FALLS, N. Y.				
Genesee Hydrate — Hydrated Lime		G	65	——
Irondequoit	0441	F	69.65	1.54
HOOSICK LIME CO., HOOSICK, N. Y.				
Ground Lime Stone		G	——	——
Troy	01901	F	54.71	0.31

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

LIME COMPOUNDS (*continued*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		Calcium oxide	Magnesium oxide
INTERNATIONAL AGRICULTURAL CORPORATION, CALEDONIA MARL BRANCH, CALEDONIA, N. Y.				
Lime Carbonate		G*	50	———
Little Valley	6698	F*	48.39	0.34
KELLEY ISLAND LIME & TRANSPORT CO., THE, CLEVELAND, O.				
Tiger Brand Hydrated Agricultural Lime		G	54	———
Elmira	0447	F	57.40	18.85
Tiger Brand Hydrated Lime for Agricultural Purposes		G	54	———
Little Valley	6697	F	58.89	1.43
LEIDY, W. H., SWARTHMORE, PA.				
Hard Wood Ashes		G	———	———
Binghamton	01158	F	52.66	0.62
NATIONAL LIME AND STONE CO., THE, CAREY, O.				
Wyandotte Chief Hydrated Agricultural Lime		G	47.08	———
Binghamton	01237	F	48.60	32.84
NIAGARA GYPSUM CO., OAKFIELD, N. Y.				
Niagara Land Plaster		G	———	———
Glens Falls	01904	F	32.76	0.70
PALMER, LOWELL M., YORK, PA.				
Challenge Brand Hydrated Lime		G	65	———
Florida	01989	F	69.37	2.46
PARAGON PLASTER & SUPPLY CO., THE, BLOOMSBURG, PA.				
Paragon Hydrate Lime		G	63	———
Whitney Point	01209	F	66.38	1.36
PLANT FOOD CO., THE, CLEVELAND, O.				
Plant Lime		G	45	———
Clymer	6648	F	50.45	2.87
REEB, M. A., BUFFALO, N. Y.				
Peerless Hydrated Lime		G	———	———
East Aurora	01897	F	45.05	60.31

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*continued*)

LIME COMPOUNDS (*concluded*)

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		Calcium oxide	Magnesium oxide
ROCK CUT STONE CO., AUBURN, N. Y.				
Ground Limestone		G*	———	———
Groton	01318	F*	44.52	1.62
ROCKLAND & ROCKPORT LIME CO., NEW YORK, N. Y.				
R-R Land Lime		G	60	———
New Hyde Park	01731	F	63.24	0 64
SECURITY CEMENT & LIME CO., BERKELEY, W. Va.				
Berkeley Hydrated Lime		G	70	———
East Aurora	01896	F	70.73	1.31
STANDARD LIME & STONE CO., THE, BUCKEYSTOWN, MD.				
Standard Hydrated Lime		G	70	———
Brewerton	01280	F	68.64	1.99
VANDERHOOF LIME CO., HAMBURG, N. J.				
Agricultural Hydrated Lime		G	70	———
Florida	01990	F	68.07	4.46
WARNER CO., CHARLES, WILMINGTON, DEL.				
Cedar Hollow Limoid		G	47	———
Union	01210	F	47.46	31.60
Limoid		G	47	———
Mineola	01740	F	47.46	31.58
WOODVILLE LIME & CEMENT CO., THE, TOLEDO, OHIO				
White Enamel Finish		G	———	———
East Aurora	6645	F	47.22	32.58

* These letters indicate, respectively, Guaranteed and Found.

REPORT OF ANALYSES OF SAMPLES OF FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1916 (*concluded*)

MIXTURES CONTAINING PHOSPHORIC ACID AND LIME COMPOUNDS.

NAME AND ADDRESS OF MANUFACTURER OR JOBBER; BRAND OR TRADE NAME; AND LOCALITY WHERE SAMPLE WAS TAKEN	Number		Phosphoric Acid		Calcium oxide	Magnesium oxide
			Available	Total		
AMERICAN AGR'L CHEMICAL CO., NEW YORK, N. Y.						
Basic Lime Phosphate		G*	13	14	30	———
Waverly	01229	F*	12.84	14.89	30.64	0.72
COE-MORTIMER CO., THE, NEW YORK, N. Y.						
E. Frank Coe's Basic Fruit and Legume Phosphate, Basic Lime Phosphate (Key Plow Brand)		G	13	14	30	———
Castle Creek	01226	F	13.08	13.76	34.56	0.72

* These letters indicate, respectively, Guaranteed and Found.

INSPECTION OF FEEDING STUFFS.*

This bulletin gives the results of the analyses[1] of samples of feeding stuffs collected by the Commissioner of Agriculture during the fall and winter of 1915–16 and by him transmitted for analysis to the Director of the New York Agricultural Experiment Station, in accordance with the provisions of Article VII of the Agricultural Law. These analyses are published by the Director of the New York Agricultural Experiment Station in accordance with the provisions of section 164 of said article.

The samples have been classified and arranged in the following order:

	PAGES.
Cottonseed meals	608
Linseed meal	611
Malt sprouts	613
Distillers' dried grains	614
Yeast or vinegar dried grains	615
Brewers' dried grains	616
Corn gluten feed and meal	617
Hominy feed	618
Compounded feeds	621
Compounded feeds, molasses	643
Poultry foods, compounded	664
Calf meals	684
Animal products	686
Alfalfa meal	694
Wheat bran	696
Wheat middlings	713
Wheat bran and wheat middlings	730
Wheat bran and low grade wheat flour	739
Wheat bran, wheat middlings, low-grade wheat flour and ground screenings	739
Buckwheat products	740
Ground corn and oats	747
Wheat bran and corn by-products	747
Wheat middlings, rye middlings and ground screenings	749
Corn feed meals	749
Barley by-products	750
Rye by-products	751
Ground screenings	753
Miscellaneous	753

[1] The analyses herewith published were made in charge of the Chemical Department of the Station, the immediate oversight of the work being assigned to Arthur W. Clark, Associate Chemist.

* A reprint of Bulletin No. 420, May, 1916.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	COTTONSEED MEALS:		Per ct.	Per ct.	Per ct.
8472	American Milling Co., Peoria, Ill. "Amco Cottonseed Meal"	Corning	G* 41. F* 39.9	6.5 7.0	10. 10.3
0555	Ames-Burns Company, Jamestown, N. Y. "Chautauqua Choice Cotton Seed Meal"	Jamestown	G 41. F 39.5	6. 6.9	10. 9.7
7797	M. F. Baringer, Philadelphia, Pa. "M F B Prime Cotton Seed Meal"	Middleville	G 38.62 F 39.	6. 7.1	12. 10.1
7895	J. E. Bartlett Co., Jackson, Mich. "Bartlett's Michigan Farmer Brand Choice Cotton Seed Meal"	Syracuse	G 41. F 45.6	7. 8.2	10. 5.7
7933	F. W. Brode & Co., Memphis, Tenn. "Dove Brand Prime Cotton Seed Meal"	Hornell	G 38.63 F 39.1	6. 7.6	10. 8.9
6392	F. W. Brode & Co., Memphis, Tenn. "Owl Brand High Grade Cotton Seed Meal"	Darien Center	G 41. F 41.8	6. 8.6	10. 7.2
7836	The Buckeye Cotton Oil Co., Cincinnati, O. "Buckeye Prime Cottonseed Meal"	Baldwinsville	G 41. F 39.7	6.5 7.1	10. 10.5
8714	The Buckeye Cotton Oil Co., Cincinnati, O. "Buckeye Prime Cottonseed Meal"	Randolph	G 38.62 F 38.7	6. 7.1	12. 10.
060	The Cotton Seed Products Co., Louisville, Ky. "Prime Cotton Seed Meal"	Bergen	G 41. F 41.0	7. 7.2	11. 9.1
7073	S. P. Davis, Little Rock, Ark. "Good Luck Brand Cotton Seed Meal"	Walton	G 41. F 40.1	7. 7.6	9. 9.
7312	The Dewey Bros. Co., Blanchester, O. "Queen Cotton Seed Meal"	Cattaraugus	G 41. F 40.2	7. 8.4	10. 8.7
8088	Empire Cotton Oil Co., Atlanta, Ga. "Gilt Edge Brand Cottonseed Meal"	Guilderland Center	G 38. F 39.4	6. 7.7	12. 8.5

*These letters indicate, respectively, Guaranteed and Found.

Analyses of Samples of Feeding Stuffs (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	Cottonseed Meals (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*
8536	Farmers & Ginners Cotton Oil Co., Austin, Tex. "Cotton Seed Meal 'Plowball' Brand"	Canastota	G* 44. F* 46.1	7. 6.7	9. 10.9
8296	Feeders Supply Co., Kansas City, Mo. "Equity Brand Cotton Seed Meal and Cake"	Lacona	G 41. F 42.3	6. 6.7	10. 7.9
7996	Feeders Supply Co., Kansas City, Mo. "Equity Brand Cotton Seed Meal and Cake"	East Bloomfield	G 41. F 43.1	6. 9.1	10.5 6.2
8572	Gus Gronauer & Co., Memphis, Tenn. "Globe Brand Cotton Seed Meal"	Ithaca	G 41. F 41.4	7. 7.4	9. 8.5
8856	Humphreys, Godwin Co., Memphis, Tenn. "Dixie Brand Cottonseed Meal"	Schoharie	G 38.62 F 42.5	6. 7.7	12. 8.1
6385	Humphreys, Godwin Co., Memphis, Tenn. "Dixie Brand Cotton Seed Meal"	Attica	G 38.62 F 42.5	6. 7.6	12. 9.1
6400	Imperial Cotto Milling Co., Memphis, Tenn. "Imperial Cotto Brand Choice Cotton Seed Meal"	Warsaw	G 41. F 43.	8. 8.	9. 7.4
8402	Imperial Cotto Milling Co., Memphis, Tenn. "Imperial Cotto Prime Cotton Seed Meal"	Geneva	G 38.62 F 36.5	7. 6.7	12. 13.6
9001	Kemper Mill & Elevator Co., Kansas City, Mo. "Anchor Brand Choice Cotton Seed Meal"	Amsterdam	G 41. F 41.4	7.5 7.9	10. 8.1
0359	Lanier Bros., Nashville, Tenn. "Canary Brand High Grade Cotton Seed Meal"	Johnstown	G 41. F 40.7	6. 8.5	10. 10.4
8464	The Louisville Cottonseed Products Co., Louisville, Ky. "Louisville Brand Cotton Seed Meal"	Watkins	G 41. F 41.3	6. 7.1	10. 9.7

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	LINSEED MEALS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*
8107	American Milling Co., Peoria, Ill. "Amco Old Process Linseed Meal"[1]	Poughkeepsie	G* 30. F* 30.6	5. 6.5	10. 7.6
7860	Archer-Daniels Linseed Co., Minneapolis, Minn. "Old Process Ground Linseed Cake"	Messengerville	G 32. F 36.6	6. 6.6	10. 6.3
8108	Kelloggs & Miller, Amsterdam, N. Y. "Pure (Old Process) Oil Meal"	Poughkeepsie	G 32. F 34.7	4. 5.9	9. 7.4
7868	Spencer Kellogg & Sons, Inc., Buffalo, N. Y. "Pure Old Process Oil Meal"	Homer	G 33. F 36.1	5. 5.5	10. 7.3
8063	Laxo Cake Meal Co., Chicago, Ill. "Old Process Laxo Cake Meal"[2]	Huntington Station	G 25. F 34.3	6. 5.7	12. 7.4
7925	The Mann Bros. Co., Buffalo, N. Y. "Pure Old Process Linseed Oil Meal"	Hunts	G 34. F 35.9	6. 7.	10. 7.1
7563	The Metzger Seed & Oil Co., Toledo, Ohio "Old Process Oil Meal"[3]	Port Chester	G 30. F 30.	5. 7.6	10. 8.2
8228	Midland Linseed Product Co., Minneapolis, Minn. "Midland Brand Pure Old Process Ground Linseed Cake"	Stittville	G 32. F 36.6	5. 6.2	9.5 6.9
0563	Motts & Co., Cleveland, Ohio "Cleveland Linseed Oil Meal"[3]	Westfield	G 30. F 30.6	5. 7.4	10. 7.8
8523	Northern Linseed Oil Co., Minneapolis, Minn. "Pure Old Process Ground Linseed Cake"	Waverly	G 33. F 34.8	6. 7.4	9. 7.5
7149	The Toledo Seed & Oil Co., Toledo, Ohio "Old Process Oil Meal"	Sidney	G 30. F 33.3	5. 6.6	10. 8.1

* These letters indicate, respectively, Guaranteed and Found.
[1] Excessive amount of weed seeds present.
[2] Guarantee: "Manufactured from crude flax seeds with the ordinary field weeds. Found: "Ground flax seed oil cake and screenings."
[3] Weed seeds present in excess.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	MALT SPROUTS:		*Per ct.*	*Per ct.*	*Per ct.*
7837	American Malting Co., Buffalo, N. Y. " No. 1 Malt Sprouts "	Baldwinsville	G* 24.15 F* 26.4	1.82 1.6	14.35 11.2
7979	Bartholomay Brewing Co., Rochester, N. Y. " Malt Sprouts "	Rochester	G 21. F 26.4	2.26 1.7	18.91 11.2
7990	Bartholomay Brewery Co., Rochester, N. Y. " Malt Sprouts "	Rochester	G 24.1 F 26.4	.84 1.3	12.58 11.1
8302	Chas. M. Cox Co., Boston, Mass. " California Malt Sprouts "	Fulton	G 25. F 23.5	1. 1.6	16. 15.6
0610	Farmers Feed Co., New York, N. Y. " Malt Sprouts "	Brooklyn	G 26.06 F 27.3	1.57 1.6	12.95 11.5
091	The Fleischmann Malting Co., Buffalo, N. Y. " Malt Sprouts "	Buffalo	G 24.2 F 24.4	1.62 1.3	11. 14.7
092	John Kam Malting Co., Buffalo, N. Y. " Malt Sprouts "	Buffalo	G 25. F 26.3	.75 1.5	16. 14.4
8463	Lembeck & Betz Eagle Brewing Co., Watkins, N. Y. " Malt Sprouts "	Watkins	G 27.76 F 29.2	.94 1.6	14.28 11.9
8738	Geo. J. Meyer Malting Co., Buffalo, N. Y. " Malt Sprouts "	Lockport	G 20.8 F 26.2	1.4 1.4	14. 12.4
8734	Perot Malting Co., Buffalo, N. Y. " Malt Sprouts "	Buffalo	G 22. F 28.5	.5 1.2	18. 12.2
8538	C. U. Snyder & Co., Chicago, Ill. " Kleinco Malt Sprouts " [1]	Haynes	G 20. F 25.	2. 1.9	16. 13.2
8411	William Taylor Lyons, N. Y " Malt Sprouts " [2]	Clyde	G —— F 22.3	—— 2.	—— 11.8

* These letters indicate, respectively, Guaranteed and Found.
[1] Malt sprouts, malted barley, barley hulls.
[2] Approximately 5.7 per ct. malted barley and 2.9 per ct. weed seed present.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	MALT SPROUTS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*
082	The C. Zwickel Malting Co. Buffalo, N. Y. "Malt Sprouts"[1]	Buffalo	G* 22. F* 26.9	1. 1.4	20. 11.4
	DISTILLERS' DRIED GRAINS:				
8131	Ajax Milling & Feed Co., Hammond, Ind. "Ajax Flakes"[2]	Poughkeepsie	G 30. F 29.9	11. 11.8	14. 8.6
8227	Geo. E. Brisbin & Co., Clyde, N. Y. "Argood Dried Distillers' Grain"[3]	Stittville	G 26. F 25.	9. 9.4	12. 11.6
6374	Clarke Bros. & Co., Peoria, Ill. "Empire State Dairy Feed"[4]	Batavia	G 30. F 31.6	12. 12.3	12. 11.5
7131	Continental Cereal Co., Peoria, Ill. "Continental Gluten Feed"[3]	Stamford	G 29. F 30.2	10.5 8.7	10.5 6.
7124	Dewey Bros. Co., Blanchester, O. "Corn 3 D Grains"[5]	Grand Gorge	G 26. F 29.4	9. 11.1	13. 7.6
6387	Dewey Bros. Co., Blanchester, O. "Eagle 3 D Grains (Dewey's Distillers' Dried)"[4]	Attica	G 30. F 32.	10. 14.2	13. 9.7
8205	Grain Products Sales Co., Buffalo, N. Y. "Columbia Corn Distillers' Grains"[4]	Utica	G 30. F 35.	10. 12.2	14. 10.7
7982	Hannis Distilling Co., Baltimore, Md. "Distillers' Dried Grains"[6]	Warsaw	G 16.44 F 16.1	7.13 7.9	14. 10.4
7993	Hannis Distilling Co., Baltimore, Md. "Distillers' Dried Grains"[6]	Bliss	G 16.44 F 16.3	7.13 8.1	14. 10.9

* These letters indicate, respectively, Guaranteed and Found.
[1] Guaranteed and found to contain a small amount of weed seeds.
[2] Guaranteed as "Corn distillers' grain"; found to be "Distillers' dried grains from corn, oats, rye and barley."
[3] From corn, oats, rye and barley.
[4] From corn, oats, barley and rye.
[5] From corn, oats and barley.
[6] Guaranteed as rye, rye and barley malt; found to be distillers' dried grains (largely rye) from rye, oats and barley.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	DISTILLERS' DRIED GRAINS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*
7830	The Hottelet Co., Milwaukee, Wis. "Hector Dried Distillers' Grains" [1]	Syracuse	G* 30. F* 33.8	10. 12.1	14. 10.6
8469	The Larrowe Milling Co., Detroit, Mich. "Brownie Grains" [2]	Horseheads	G 26. F 27.2	7. 11.8	9. 6.5
8731	Melvale Distillery Co., Baltimore, Md. "Distillers' Dried Grains" [3]	East Aurora	G 16.94 F 15.5	7.95 8.	13.8 12.1
7920	Merchants Distilling Co., Terre Haute, Ind. "Merchants High Grade Dairy Feed" [4]	Perry	G 30. F 33.9	11. 12.3	14. 9.2
9009	The Ubiko Milling Co., Cincinnati, O. "Fourex Grains, Distillers' Dried Grains" [5]	Amsterdam	G 31. F 32.2	12. 13.4	13. 10.5
	YEAST OR VINEGAR DRIED GRAINS:				
8187	Atlantic Export Co., New York, N. Y. "Atlantic Grains" [6]	Brewster	G 20. F 19.3	6. 7.1	18. 16.2
8453	The Dewey Bros. Co., Blanchester, O. "Bourbon 3 D Grains" [7]	Geneva	G 24. F 25.	8. 10.	14. 13.4
7383	Donahue Stratton Co., Milwaukee, Wis. "Onyx Dried Grains" [8]	Potsdam	G 20. F 19.5	6. 7.1	16. 15.9
7577	Fleischmann Mfg. Co., Peekskill, N. Y. "Fleischmann's Dried Grains" [9]	Peekskill	G 18. F 19.4	6.5 6.7	22. 16.3

* These letters indicate, respectively, Guaranteed and Found.
[1] From corn, oats and barley.
[2] From corn, barley, rye and oats.
[3] Guaranteed as rye, rye and barley malt; found to be distillers' dried grains (largely rye) from rye, oats and barley.
[4] From corn, oats, barley and rye.
[5] From corn, oats, rye and barley.
[6] Guaranteed as "Distillers' dried grains"; found to be yeast or vinegar dried grains, from corn, oats, barley, rye and malt sprouts.
[7] From corn, oats, barley and malt sprouts.
[8] Guaranteed as "Made largely of malt and corn"; found to be yeast or vinegar dried grains, from corn, oats, barley, rye and malt sprouts.
[9] Guaranteed: "Corn, rye, barley and malt sprouts." Found: Yeast or vinegar dried grains, from corn, oats, barley, rye and malt sprouts.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	YEAST AND VINEGAR DRIED GRAINS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*
8520	Illinois Vinegar Mfg. Co., Chicago, Ill. "Ivy Grains"[1]	Sherburne	G* 19. F* 18.2	7. 6.4	19. 18.1
	BREWERS' DRIED GRAINS:				
7987	Anheuser-Busch Brewing Ass'n, St. Louis, Mo. "Steam Dried Brewers' Grains"	Greenwood	G 21. F 34.4	6. 7.7	18. 11.
8321	M. F. Baringer, Philadelphia, Pa. "Dried Brewers' Grains"	West Winfield	G 25. F 25.9	6. 6.8	15. 13.6
7991	Bartholomay Brewery Co., Rochester, N. Y. "Dried Brewers' Grains"	Rochester	G 21.13 F 20.8	5.1 7.	19.4 15.7
6391	Farmers Feed Co., New York, N. Y. "Bull Brand Dried Brewers' Grains"	Darien Center	G 27.2 F 30.4	6.3 7.3	17.2 12.4
8192	W. Gottlieb, New York, N. Y. "Regina Brewers' Dried Grains"	Towners	G 25. F 25.	6. 6.	15. 13.9
7344	Hottelet & Co., Milwaukee, Wis. "Holstein Dried Brewers' Grains"	Olean	G 25. F 21.8	5. 8.5	17. 16.4
9016	Milwaukee Grains & Feed Co., Milwaukee, Wis. "Crown Brewers' Dried Grains"	Goshen	G 25. F 30.1	5. 6.6	15. 12.
8509	K. & E. Neumond, St. Louis, Mo. "Goldnes Kalb Dried Brewers' Grains"	Greene	G 24. F 28.8	6. 6.9	13. 12.2
8551	Pennsylvania Central Brewing Co., Scranton, Pa. "Brewers' Dried Grains"	Binghamton	G 23.71 F 24.6	7.14 6.7	15.85 14.2
7080	Rosekrans Snyder Co., Philadelphia, Pa. "Pilsner Brewers' Dried Grains"	Walton	G 25. F 31.3	5. 6.6	18. 10.5

* These letters indicate, respectively, Guaranteed and Found.

[1] Guaranteed: "Corn, barley, malt and sprouts." Found: Yeast or vinegar dried grains, from corn oats, barley, rye and malt sprouts.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	BREWERS' DRIED GRAINS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*
8325	Western Grains & Feed Co., Chicago, Ill. "Dried Brewers' Grains"	Fulton	G* 25. F* 22.3	5. 8.8	16. 16.
	CORN GLUTEN FEED:				
7924	American Maize Products Co., New York, N. Y. "Cream of Corn Gluten Feed"	Perry	G 23. F 24.7	2.5 2.6	8.5 5.9
0352	Clinton Sugar Refining Co., Clinton, Ia. "Clinton Corn Gluten Feed"	Mechanicville	G 23. F 26.9	3. 3.6	8. 5.7
7855	Clinton Sugar Refining Co., Clinton, Ia. "Clinton Corn Gluten Feed"	Homer	G 23. F 25.4	3. 4.2	8. 5.9
0558	Corn Products Refining Co., New York, N. Y. "Buffalo Corn Gluten Feed"	Little Valley	G 23. F 26.6	1. 2.8	8.5 6.7
0754	Corn Products Refining Co., New York, N. Y. "Buffalo Corn Gluten Feed"	Belmont	G 23. F 27.8	1. 2.8	8.5 7.
6373	Corn Products Refining Co., New York, N. Y. "Buffalo Corn Gluten Feed"	Batavia	G 23. F 27.3	1. 2.5	8.5 6.
8560	Corn Products Refining Co., New York, N. Y. "Buffalo Corn Gluten Feed"	Homer	G 23. F 24.5	1. 3.6	8.5 7.1
7142	Corn Products Refining Co., New York, N. Y. "Globe Gluten Feed"	Davenport Center	G 23. F 25.1	1. 3.6	8.5 6.4
6384	Douglas Company, Cedar Rapids, Ia. "Douglas Corn Gluten Feed"	Attica	G 23. F 25.3	2. 4.3	8. 5.5
7139	J. C. Hubinger Bros. Co., Keokuk, Ia. "K K K Corn Gluten Feed"	Hobart	G 23. F 22.9	2.4 2.2	7.50 6.8
8555	Piel Bros. Starch Co., Indianapolis, Ind. "PBro Gluten Feed"	Norwich	G 25. F 27.8	2. 2.	8. 5.5

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	CORN GLUTEN FEED (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*
8120	Union Starch & Refining Co., Edinburg, Ind. " Union Corn Gluten Feed "	Poughkeepsie	G* 23. F* 22.9	3. 4.5	8. 5.9
	CORN GLUTEN MEAL:				
7347	Corn Products Refining Co., New York, N. Y. " Diamond Corn Gluten Meal "	Olean	G 40. F 47.5	1.5 1.3	4. .8
	HOMINY FEED:				
8133	American Hominy Co., Indianapolis, Ind. " Homco Feed "	Poughkeepsie	G 9.5 F 10.2	7. 8.9	7. 4.6
7334	Ames-Burns Co., Jamestown, N. Y. " A-B-C Fine White Hominy "	Cuba	G 9. F 10.6	7. 7.3	5 5.3
0592	E. I. Bailey, Cleveland, O. " Pearl Hominy Feed "	North Collins	G 9. F 10.4	7. 7.	8. 3.
8183	The Baltimore Pearl Hominy Co., Baltimore, Md. " Hominy Feed "	Brewster	G 10. F 11.6	6. 7.3	8. 3.5
7578	M. F. Baringer, Philadelphia, Pa. " Hominy Feed "	Peekskill	G 9. F 10.8	6. 8.	10. 2.
8062	S. W. Bowne Co., Brooklyn, N. Y. " Hominy Chop "	Huntington Station	G 10. F 11.	8. 11.2	6.65 3.9
7126	Buffalo Cereal Co., Buffalo, N. Y. " Bufceco Hominy Feed "	Grand Gorge	G 10. F 11.4	6. 6.4	5. 4.1
7871	Cereal Mills Co., Wausau, Wis. " Hominy Feed "	Cuyler	G 11.25 F 11.1	8.5 8.7	4. 3.9
8713	Deutsch & Sickert Co., Milwaukee, Wis " Success Hominy Feed "	Buffalo	G 9. F 9.5	7. 8.2	4. 3.7
8250	Eagle Roller Mill Co., New Ulm, Minn. " Hominy Feed "	Oneonta	G 10.1 F 10.	7.93 6.7	6.43 5.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	HOMINY FEED (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*
8318	Elevator Milling Co., Springfield, Ill. "Ideal Hominy Feed Kiln Dried"	Carthage	G* 11.02 F* 11.1	7.70 8.7	—— 4.5
8274	Empire Grain & Elevator Co., Binghamton, N. Y. "Pearl Hominy"	Bridgewater	G 10. F 10.8	7. 7.9	6. 4.1
6395	Evans Milling Co., Indianapolis, Ind. "Evans Hominy Feed"	Darien Center	G 10. F 11.6	7.5 9.2	7. 4.3
7847	U. S. Frumentum Co., Detroit, Mich. "Frumentum Hominy Feed"	Georgetown Station	G 9.5 F 11.3	7. 8.6	7. 3.8
7793	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Hominy Feed"	Poland	G 10. F 10.4	6. 6.7	5. 5.2
7367	R. H. McEwen Milling Co., Ogdensburg, N. Y. "Yellow Hominy Feed"	Ogdensburg	G 9. F 9.6	5. 5.3	6. 2.9
053	Marco Mills, Pine Bluff, Ark. "Hominy Feed (M)"	North Java	G 9.5 F 11.8	5.5 8.1	10. 6.5
9013	Miner-Hillard Milling Co., Wilkesbarre, Pa. "Choice Steam Cooked Hominy Feed"	Chester	G 10. F 10.3	5. 5.7	5. 3.8
7030	Mystic Milling Co., Sioux City, Ia. "Hominy Feed"	McLean	G 11. F 10.8	6.5 7.7	5. 3.6
7146	Mystic Milling Co., Sioux City, Ia "Hominy Feed"	Sidney	G 11. F 11.	6.5 6.8	5. 3.7
0356	National Feed Co., St. Louis, Mo. "Pure Hominy Feed"	Fonda	G 10.5 F 12.	8.5 7.9	10. 4.9
7899	Nebraska Corn Mills Lincoln, Neb. "Hominy Feed"	Sheds	G 10. F 11.4	9. 9.7	4.5 5.9

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	HOMINY FEED (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*
8532	A. Nowak & Son, Buffalo, N. Y. " Justice Brand Hominy '	South Lansing	G* 8. F* 11.6	6. 6.9	8. 4.6
8132	The Patent Cereals Co., Geneva, N. Y. " Hominy Feed "	Poughkeepsie	G 10. F 10.9	6. 6.4	5. 5.2
8151	The Quaker Oats Co., Chicago, Ill. " Yellow Hominy Feed "	Poughkeepsie	G 9. F 11.3	4. 9.1	4. 3.
7834	M. G. Rankin & Co., Milwaukee, Wis. " Jersey Hominy Feed "	Baldwinsville	G 10. F 10.4	6. 5.8	5. 3.
8534	J. E. Soper Co., Boston, Mass. " Blue Ribbon Hominy Chop "	Stockbridge	G 10. F 10.9	6. 6.3	5. 4.4
7823	Suffern Hunt Mills, Decatur, Ill. " Acme Hominy Feed "	Berkshire	G 9.3 F 11.4	7.1 8.7	10. 4.4
0174	Thompson & Mould, Goshen, N. Y. " Special Hominy Feed "	Goshen	G 10. F 12.3	7. 9.2	4.75 2.7

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	Per ct.	Per ct.	
	COMPOUNDED FEEDS:					
7349	Acme Milling Co., Olean, N. Y. "Acme Feed"	Olean	G* 7.	3.	9.	Corn, hominy, oat hulls and one-half of one per ct. salt.
			F* 9.9	1.7	3.3	Ground corn, yellow hominy feed, oat hulls, trace of salt.
8060	J. & T. Adikes, Jamaica, N. Y. "Ground Feed"	Jamaica	G 7.	3.	8.	Barley, ground corn, corn cob and corn bran, oats and oat hulls, salt, grain screenings.
			F 8.9	2.	7.4	As certified.
7947	Akron Feed & Milling Co., Akron, O. "Portage Stock Feed"	Addison	G 10.	4.	10.	Either white or yellow shelled corn, barley, oat shorts, oat hulls, oat middlings and one-half of one per ct. salt.
			F 9.7	4.6	11.5	Ground (white) corn, ground barley, oat shorts, oat middlings, oat hulls, salt.
8199	American Hominy Co., Toledo Elevator Branch, Indianapolis, Ind. "Star Feed"	Amenia	G 7.	5.5	12.5	Composed of hominy feed and ground corn cob, containing one-half of one per ct. salt.
			F 8.7	6.6	10.7	As certified.
8407	Henry E. Amos, Weedsport, N. Y. "Cow Feed"	Weedsport	G ——	——	——	
			F 20.6	5.3	16.3	Cottonseed meal, oat hulls, buckwheat middlings, wheat middlings, salt.
6794	J. D. Atwater, Genoa, N. Y. "Corn Meal and Oat Feed"	Genoa	G 6.25	3.16	15.17	100 pounds corn meal, 100 pounds oat feed mixed half and half.
			F 7.4	8.2	12.6	Corn meal, oat shorts, oat middlings, oat hulls.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
0568	E. A. Bagg, Conewango Valley, N. Y. "Daisy Dairy Ration"	—	G* 24.	6.	11.	Corn distillers' grains, oil meal, cottonseed meal, corn meal, malt sprouts, bull brand distillers' grains, buckwheat midds, gluten, wheat bran.
		Conewango Valley	F* 25.8	6.2	10.3	Distillers' dried grains, linseed oil meal, cottonseed meal, corn meal, malt sprouts, brewers' dried grains, buckwheat middlings, corn gluten feed, wheat bran.
8270	J. J. Bartholomew & Sons, Inc., Vernon, N. Y. "Vernon Dairy Feed"	Vernon	G 24.	5.	10.	Corn distillers' dried grains, cottonseed meal, corn gluten feed, brewers' dried grains, corn meal, hominy, malt sprouts, wheat bran, linseed meal.
			F 24.5	6.8	9.4	Distillers' dried grains, cottonseed meal, corn gluten feed, brewers' dried grains, corn meal, hominy feed, malt sprouts, wheat bran, linseed meal.
8081	S. W. Bowne Co., Brooklyn, N. Y. "Ground Feed"	Brooklyn	G 7.	3.	11.	Corn meal, hominy chops, oat hulls.
			F 10.1	5.1	4.6	Corn meal, hominy feed, oat hulls.
8072	Brooklyn Elevator & Milling Co., Brooklyn, N. Y. "Bemco Stock Feed"	Brooklyn	G 9.	3.	8.	Corn meal, ground oats, ground barley, oat hulls, whole screenings, wheat bran.
			F 9.7	3.3	3.4	As certified.
8135	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Chop Feed"	Poughkeepsie	G 7.	3.	9.	Ground corn, hominy feed, oat shorts and oat hulls.
			F 9.5	6.2	11.5	As certified.

8201	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Creamery Feed"	Herkimer	G	18.	4.	9.	Ground corn, wheat bran, middlings, hominy feed, corn gluten feed, cottonseed meal, oat shorts, oat middlings, and oat hulls.
			F	18.9	4.9	11.8	As certified.
081	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Dairy Feed"	Buffalo	G	12.	3.	9.	Ground corn, wheat bran and middlings, hominy feed, corn gluten feed, oat shorts, oat middlings, oat hulls.
			F	13.3	5.5	10.7	As certified.
8804	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Horse Feed"	Hudson Falls	G	10.	4.	9.	Ground oats, corn and barley, wheat middlings, hominy feed, oat shorts, oat middlings and oat hulls, corn gluten feed, linseed meal.
			F	12.1	4.1	9.4	As certified.
7861	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Steam Cooked Feed"	Marathon	G	8.	4.	9.	Ground corn and oats, hominy feed, oat shorts, oat hulls and oat middlings.
			F	9.9	5.1	7.1	As certified.
7127	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Stock Feed"	Grand Gorge	G	8.	4.	9.	Ground corn and oats, wheat middlings, hominy feed, oat shorts, oat hulls, and oat middlings.
			F	10.3	5.9	8.8	Ground corn, hominy feed, oat hulls, oat shorts, wheat middlings probably present, wheat starches identified.
8708	Buffalo Cereal Co., Buffalo, N. Y. "Iroquois Chop Feed"	Buffalo	G	7.	3.	9.	Ground corn, hominy feed, oat shorts and oat hulls.
			F	10.1	5.9	4.1	As certified.
7125	Chapin & Co., Hammond, Ind. "Unicorn Dairy Feed"	Grand Gorge	G	26.	5.5	10.	Corn distillers' grains, cottonseed meal, linseed meal, hominy meal, gluten feed, cornstarch by-product with corn bran, brewers' grain, barley feed, malt sprouts, wheat bran.
			F	26.3	6.3	10.1	Distillers' dried grains, cottonseed meal, linseed meal, hominy meal, corn gluten feed, brewers' dried grains, feed barley, malt sprouts, wheat bran.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
6386	Chesbro Bros., Attica, N. Y. "Mixed Feed 'E'"	Attica	G* 23.	6.	10.	Distillers' dried feed, linseed meal, corn meal, cottonseed meal, corn gluten feed, wheat bran, wheat middlings.
			F* 25.2	6.2	6.7	As certified.
8541	The Chesbro Milling Co., Salamanca, N. Y. "Chesbro's Stock Feed"	Binghamton	G 8.	3.25	10.	Corn, barley, cottonseed meal, red dog flour, oat shorts, oat midds, oat hulls, one-half of one per ct. salt.
			F 8.5	5.	11.2	As certified.
8535	Chesbro Milling Co., Inc., Salamanca, N. Y. "Peerless Dairy Feed"	Canastota	G 24.	7.	10.	Choice distillers' grains, choice cottonseed meal, linseed meal, winter wheat bran, wheat middlings, malt sprouts, hominy, salt three-fourths of one per ct., corn.
			F 27.1	6.5	8.9	Distillers' dried grains, cottonseed meal, linseed meal, wheat bran, wheat middlings, malt sprouts, hominy feed, salt.
8440	The Chesbro Milling Co., Salamanca, N. Y. "Trojan Stock Feed"	Livonia	G 7.	4.	18.	Made from corn, barley, oat shorts, oat midds, oat hulls, oat by-products, hominy and one-half of one per ct. salt.
			F 9.8	5.4	11.9	Ground corn, ground barley, oat shorts, oat middlings, oat hulls, hominy feed, cottonseed meal, salt.
8189	Frank E. Cole, Pawling, N. Y. "C. W. B. Feed"	Pawling	G 10.	5.	12.	Corn, barley sprouts and screenings.
			F 10.4	3.5	9.0	Ground corn, barley malt sprouts, ground grain screenings.

8525	The Commercial Milling Co., Detroit, Mich. "Henkel's Chop Feed"	Whitney Point	G	9.	4.5	9.	Corn meal, rye and oat midds, oats and oat hulls.
			F	9.5	4.1	6.8	Corn meal, oats, oat middlings, oat hulls, rye middlings present in small amounts.
8282	The Commercial Milling Co., Detroit, Mich. "Henkels Fine White Feed"	Rome	G	16.	4.	6.	Wheat and rye middlings with ground screenings not exceeding mill run and corn product.
			F	15.1	4.3	6.9	Wheat middlings, rye middlings, ground screenings, corn products present, probably corn flour.
0153	W. H. Coonrod, Est., Port Jervis, N. Y. "Horse Feed"	Port Jervis	G	8.	3.	14.	Ground corn, corn bran, ground oats, wheat and rye middlings, oat meal mill by products (oat hulls and oat middlings), Star feed (hominy feed and ground corn cob), wheat flour and one-half of one per ct. salt.
			F	9.	4.5	10.2	As certified.
0160	The Corno Mills Co., St. Louis, Mo. "Corno Mills Horse and Mule Feed"	Albany	G	10.	3.5	12	Ground alfalfa, ground corn, cottonseed meal, hominy feed, oat middlings, oat shorts and oat hulls.
			F	11.1	2.5	13.3	As certified.
8078	The Corno Mills, St. Louis, Mo. "Corno Mills Horse and Mule Feed"	Brooklyn	G	10.	3.5	12.	Ground alfalfa, ground corn, cottonseed meal, hominy feed, oat middlings, oat shorts and oat hulls.
			F	10.4	3.7	13.2	As certified.
8715	E. N. Cross, Randolph, N. Y. "Red Mill Perfection Dairy Feed"	Randolph	G	24.	7.	11.	Corn distillers' grains, brewers' dried grains, hominy feed and corn meal, cottonseed meal, wheat bran, old process linseed meal, malt sprouts, corn gluten feed.
			F	25.6	6.1	9.6	As certified.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
8311	Burney P. Davis, Vermillion, N. Y. "Dairy Feed"	Vermillion	G* ——	——	——	Bran, Ajax Buffalo gluten, cottonseed meal, oil meal, ground oats.
			F* 26.3	7.4	9.2	Wheat bran, corn gluten feed, distillers' dried grains, linseed meal, cottonseed meal, ground oats.
8575	Deposit Milling Co., Deposit, N. Y. "Deposit White Mixed Feed"	Deposit	G 14.	4.	8.	Low grade corn and wheat flour, wheat bran, not exceeding mill run screenings.
			F 14.6	4.3	5.4	Wheat bran, low grade wheat and corn flour, traces of ground screenings.
8736	The Dewey Bros. Co., Blanchester, O. "Dewey's Stock Feed"	Wellsville	G 11.	3.5	12.	Hominy feed, wheat and rye middlings, oil meal, C. S. meal, oat feed (oat middlings, oat hulls, oat shorts), one-half of one per ct. of salt.
			F 13.4	4.2	12.8	Hominy feed, wheat middlings, rye middlings, linseed meal, cottonseed meal, oat shorts, oat middlings, oat hulls, salt.
8165	The Albert Dickinson Co., Chicago, Ill. "White Cross Stock Feed"	Beacon	G 10.	3.5	10.	Ground oats, ground barley, corn feed meal, wheat meal, ground corn bran, cottonseed meal, salt one-half of one per ct.
			F 10.9	3.5	6.1	Crushed oats, crushed barley, corn feed meal, ground corn bran, ground corn offal, wheat meal, cottonseed meal, salt.

0182	The Albert Dickinson Co., Chicago, Ill. " Dickinson's Globe Developing Feed "	Newburgh	G 10.	2.5	5.	Corn, wheat, kaffir corn, hulled oats and millet.
			F 10.3	3.7	3.	Cracked corn, wheat, kaffir corn, hulled oats, millet, approximately 3.2 per ct. buckwheat.
7385	Dock & Coal Co., Plattsburg, N. Y. " Dandy Feed "	Plattsburg	G 8.	5.	8.	Corn meal and oat midds, oats and oat hulls.
			F 9.9	5.3	4.2	Corn feed meal, oats, oat hulls, oat middlings.
8540	R. D. Eaton Grain & Feed Co., Norwich, N. Y. " Eaton's Special Dairy Feed "	Norwich	G 12.	3.	12.	Buckwheat and kaffir corn meal, alfalfa meal, linseed oil meal, pea meal, brewers' grain, corn meal, cottonseed meal, oats and barley.
			F 11.9	4.4	6.6	Ground oats, barley, kaffir corn and buckwheat, alfalfa meal, linseed meal, pea meal, brewers' dried grains, corn meal, cottonseed meal.
8452	Edwards & Loomis Co., Chicago, Ill. " Pioneer Feed "	Geneva	G 10.	2.5	9.	Corn feed meal, oat feed, wheat middlings, wheat bran, corn gluten feed.
			F 10.2	3.	8.2	Corn feed meal, oat hulls, oat middlings, wheat bran, wheat middlings, corn gluten feed.
7129	Elmore Milling Co., Oneonta, N. Y. " Elmore Milk Grains "	Stamford	G 25.	6.	10.	Corn distillers' dried grains, 41 per ct. cottonseed meal, corn gluten feed, hominy meal, choice wheat bran, barley, malt sprouts, dried brewers' grains, a little fine table salt, old process linseed meal.
			F 26.6	6.8	9.5	Distillers' dried grains, cottonseed meal, corn gluten feed, hominy meal, wheat bran, barley, malt sprouts, brewers' dried grains, linseed meal, salt.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
8828	Elmore Milling Co., Oneonta, N. Y "Elmore's Stock Feed"	Ballston Spgs.	G* 10.	4.	12.	Corn, meal, hominy, dried brewers' grain, wheat bran, oat meal mill by-product (oat middlings, oat shorts, oat hulls), salt.
			F* 9.8	3.8	10.9	As certified.
7864	Empire Grain & Elevator Co., Binghamton, N. Y. "Egee Stock Feed"	Apulia Station	G 10.	4.50	12.	Hominy feed, maizo corn oil meal, maizo red dog flour, oat meal mill by-product (oat middlings, oat hulls, oat shorts), and salt.
			F 11.	6.5	8.1	Hominy feed, corn germ meal, white corn flour, oat middlings, oat shorts, oat hulls, trace of salt.
7341	The Empire Mfg. Co. Franklinville, N. Y. "Empire Stock Feed"	Franklinville	G 20.	3.	8.	Malt sprouts, wheat bran, corn, cottonseed meal, gluten, oil meal, distillers' grains, salt.
			F 23.4	4.5	8.9	Wheat bran, malt sprouts, cottonseed meal, ground corn, corn gluten feed, linseed meal, distillers' dried grains, salt.
7857	Empire Mills, Olean, N. Y. "Empire Feed"	McGrawville	G 7.5	3.	9.	Corn, hominy, oat hulls.
			F 9.1	3.9	6.8	Ground corn, hominy feed, oat hulls.
0369	Empire Mill & Coal Co., Schaghticoke, N. Y. "Empire Milk Producer"	Schaghticoke	G 14.5	2.4	10.5	Corn meal, wheat bran, rye feed, cottonseed, Onyx dried grains, ground screening from rye, oats and corn, mill sweepings, fine salt.
			F 18.9	5.2	8.5	Corn meal, wheat bran, rye bran, rye middlings, cottonseed meal, yeast or vinegar dried grains, ground screenings from rye, oats and corn, salt.

8604	Empire Stock & Poultry Food Co., Auburn, N. Y. "Empire Stock Regulator"	Auburn	G	23.5	7.3	18.3	Sulphur, gentiana, lutea, sem. fenugreek, sem. anise, pulv. capsicum, oil meal, pulv. carbo lig., sod. chlorid.
			F	24.4	7.6	15.7	Linseed oil meal, sulphur, gentian, fenugreek, anise, capsicum, charcoal, salt.
069	Federal Milling Co., Lockport, N. Y. "Lucky Oat-Corn Feed"	Lockport	G	8.	3.	8.	Crushed oats, cracked corn, corn feed meal, hominy feed.
			F	10.4	5.3	5.3	As certified.
7966	Federal Milling Co., Lockport, N. Y. "Lucky Oat-Corn Feed"	Spencerport	G	9.	3.	8.	Crushed oats, corn feed meal, hominy feed and cracked corn.
			F	11.2	3.2	6.1	As certified.
7885	General Flour & Feed Co., Buffalo, N. Y. "Banner Horse Feed"	Syracuse	G	7.	2.5	13.5	Corn feed meal, ground oats, cracked corn, oat clippings, oat middlings, ground oat hulls, salt, linseed meal.
			F	8.4	2.7	13.1	Cracked corn, corn feed meal, ground oats, oat middlings, oat hulls, clipped oat by-products, linseed meal, salt.
7828	General Flour & Feed Co., Buffalo, N. Y. "Honest Cow Feed"	Syracuse	G	24.	6.	9.	Distillers' dried grains, corn gluten feed, wheat middlings, corn meal, wheat bran, one per ct. salt, corn bran, cottonseed meal, linseed meal.
			F	25.3	6.7	9.	As certified.
077	J. Gorman, Buffalo, N. Y. "Boat Sweepings"	Buffalo	G	5.	2.	14.	Sweepings from boats loaded with flour and feed and consists of several materials having feeding stuffs value, but impossible to name each ingredient contained therein.
			F	16.	4.2	6.	Wheat bran, wheat middlings, wheat flour, corn meal, linseed meal, corn gluten feed, distillers' dried grains, alfalfa, barley, peas, wheat.

* These letters indicate, respectively, Guaranteed and Found.

Analyses of Samples of Feeding Stuffs (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	Compounded Feeds (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
0568	E. A. Bagg, Conewango Valley, N. Y. "Daisy Dairy Ration"	— Conewango Valley	G* 24.	6.	11.	Corn distillers' grains, oil meal, cottonseed meal, corn meal, malt sprouts, bull brand distillers' grains, buckwheat midds, gluten, wheat bran.
			F* 25.8	6.2	10.3	Distillers' dried grains, linseed oil meal, cottonseed meal, corn meal, malt sprouts, brewers' dried grains, buckwheat middlings, corn gluten feed, wheat bran.
8270	J. J. Bartholomew & Sons, Inc., Vernon, N. Y. "Vernon Dairy Feed"	Vernon	G 24.	5.	10.	Corn distillers' dried grains, cottonseed meal, corn gluten feed, brewers' dried grains, corn meal, hominy, malt sprouts, wheat bran, linseed meal.
			F 24.5	6.8	9.4	Distillers' dried grains, cottonseed meal, corn gluten feed, brewers' dried grains, corn meal, hominy feed, malt sprouts, wheat bran, linseed meal.
8081	S. W. Bowne Co., Brooklyn, N. Y. "Ground Feed"	Brooklyn	G 7.	3.	11.	Corn meal, hominy chops, oat hulls.
			F 10.1	5.1	4.6	Corn meal, hominy feed, oat hulls.
8072	Brooklyn Elevator & Milling Co., Brooklyn, N. Y. "Bemco Stock Feed"	Brooklyn	G 9.	3.	8.	Corn meal, ground oats, ground barley, oat hulls, whole screenings, wheat bran.
			F 9.7	3.3	3.4	As certified.
8135	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Chop Feed"	Poughkeepsie	G 7.	3.	9.	Ground corn, hominy feed, oat shorts and oat hulls.
			F 9.5	6.2	11.5	As certified.

8201	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Creamery Feed"	Herkimer	G 18.	4.	9.	Ground corn, wheat bran, middlings, hominy feed, corn gluten feed, cottonseed meal, oat shorts, oat middlings, and oat hulls.
			F 18.9	4.9	11.8	As certified.
081	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Dairy Feed"	Buffalo	G 12.	3.	9.	Ground corn, wheat bran and middlings, hominy feed, corn gluten feed, oat shorts, oat middlings, oat hulls.
			F 13.3	5.5	10.7	As certified.
8804	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Horse Feed"	Hudson Falls	G 10.	4.	9.	Ground oats, corn and barley, wheat middlings, hominy feed, oat shorts, oat middlings and oat hulls, corn gluten feed, linseed meal.
			F 12.1	4.1	9.4	As certified.
7861	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Steam Cooked Feed"	Marathon	G 8.	4.	9.	Ground corn and oats, hominy feed, oat shorts, oat hulls and oat middlings.
			F 9.9	5.1	7.1	As certified.
7127	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Stock Feed"	Grand Gorge	G 8.	4.	9.	Ground corn and oats, wheat middlings, hominy feed, oat shorts, oat hulls, and oat middlings.
			F 10.3	5.9	8.8	Ground corn, hominy feed, oat hulls, oat shorts, wheat middlings probably present, wheat starches identified.
8708	Buffalo Cereal Co., Buffalo, N. Y. "Iroquois Chop Feed"	Buffalo	G 7.	3.	9.	Ground corn, hominy feed, oat shorts and oat hulls.
			F 10.1	5.9	4.1	As certified.
7125	Chapin & Co., Hammond, Ind. "Unicorn Dairy Feed"	Grand Gorge	G 26.	5.5	10.	Corn distillers' grains, cottonseed meal, linseed meal, hominy meal, gluten feed, cornstarch by-product with corn bran, brewers' grain, barley feed, malt sprouts, wheat bran.
			F 26.3	6.3	10.1	Distillers' dried grains, cottonseed meal, linseed meal, hominy meal, corn gluten feed, brewers' dried grains, feed barley, malt sprouts, wheat bran.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
6386	Chesbro Bros., Attica, N. Y. "Mixed Feed 'E'"	Attica	G* 23.	6.	10.	Distillers' dried feed, linseed meal, corn meal, cottonseed meal, corn gluten feed, wheat bran, wheat middlings.
			F* 25.2	6.2	6.7	As certified.
8541	The Chesbro Milling Co., Salamanca, N. Y. "Chesbro's Stock Feed"	Binghamton	G 8.	3.25	10.	Corn, barley, cottonseed meal, red dog flour, oat shorts, oat midds, oat hulls, one-half of one per ct. salt.
			F 8.5	5.	11.2	As certified.
8535	Chesbro Milling Co., Inc., Salamanca, N. Y. "Peerless Dairy Feed"	Canastota	G 24.	7.	10.	Choice distillers' grains, choice cottonseed meal, linseed meal, winter wheat bran, wheat middlings, malt sprouts, hominy, salt three-fourths of one per ct., corn.
			F 27.1	6.5	8.9	Distillers' dried grains, cottonseed meal, linseed meal, wheat bran, wheat middlings, malt sprouts, hominy feed, salt.
8440	The Chesbro Milling Co., Salamanca, N. Y. "Trojan Stock Feed"	Livonia	G 7.	4.	18.	Made from corn, barley, oat shorts, oat midds, oat hulls, oat by-products, hominy and one-half of one per ct. salt.
			F 9.8	5.4	11.9	Ground corn, ground barley, oat shorts, oat middlings, oat hulls, hominy feed, cottonseed meal, salt.
8189	Frank E. Cole, Pawling, N. Y. "C. W. B. Feed"	Pawling	G 10.	5.	12.	Corn, barley sprouts and screenings.
			F 10.4	3.5	9.0	Ground corn, barley malt sprouts, ground grain screenings.

8525	The Commercial Milling Co., Detroit, Mich. "Henkel's Chop Feed"	Whitney Point	G	9.	4.5	9.	Corn meal, rye and oat midds, oats and oat hulls.
			F	9.5	4.1	6.8	Corn meal, oats, oat middlings, oat hulls, rye middlings present in small amounts.
8282	The Commercial Milling Co., Detroit, Mich. "Henkels Fine White Feed"	Rome	G	16.	4.	6.	Wheat and rye middlings with ground screenings not exceeding mill run and corn product.
			F	15.1	4.3	6.9	Wheat middlings, rye middlings, ground screenings, corn products present, probably corn flour.
0153	W. H. Coonrod, Est., Port Jervis, N. Y. "Horse Feed"	Port Jervis	G	8.	3.	14.	Ground corn, corn bran, ground oats, wheat and rye middlings, oat meal mill by products (oat hulls and oat middlings), Star feed (hominy feed and ground corn cob), wheat flour and one-half of one per ct. salt.
			F	9.	4.5	10.2	As certified.
0160	The Corno Mills Co., St. Louis, Mo. "Corno Mills Horse and Mule Feed"	Albany	G	10.	3.5	12	Ground alfalfa, ground corn, cottonseed meal, hominy feed, oat middlings, oat shorts and oat hulls.
			F	11.1	2.5	13.3	As certified.
8078	The Corno Mills, St. Louis, Mo. "Corno Mills Horse and Mule Feed"	Brooklyn	G	10.	3.5	12.	Ground alfalfa, ground corn, cottonseed meal, hominy feed, oat middlings, oat shorts and oat hulls.
			F	10.4	3.7	13.2	As certified.
8715	E. N. Cross, Randolph, N. Y. "Red Mill Perfection Dairy Feed"	Randolph	G	24.	7.	11.	Corn distillers' grains, brewers' dried grains, hominy feed and corn meal, cottonseed meal, wheat bran, old process linseed meal, malt sprouts, corn gluten feed.
			F	25.6	6.1	9.6	As certified.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
8311	Burney P. Davis, Vermillion, N. Y. "Dairy Feed"	Vermillion	G* ——	——	——	Bran, Ajax Buffalo gluten, cottonseed meal, oil meal, ground oats.
			F* 26.3	7.4	9.2	Wheat bran, corn gluten feed, distillers' dried grains, linseed meal, cottonseed meal, ground oats.
8575	Deposit Milling Co., Deposit, N. Y. "Deposit White Mixed Feed"	Deposit	G 14.	4.	8.	Low grade corn and wheat flour, wheat bran, not exceeding mill run screenings.
			F 14.6	4.3	5.4	Wheat bran, low grade wheat and corn flour, traces of ground screenings.
8736	The Dewey Bros. Co., Blanchester, O. "Dewey's Stock Feed"	Wellsville	G 11.	3.5	12.	Hominy feed, wheat and rye middlings, oil meal, C. S. meal, oat feed (oat middlings, oat hulls, oat shorts), one-half of one per ct. of salt.
			F 13.4	4.2	12.8	Hominy feed, wheat middlings, rye middlings, linseed meal, cottonseed meal, oat shorts, oat middlings, oat hulls, salt.
8165	The Albert Dickinson Co., Chicago, Ill. "White Cross Stock Feed"	Beacon	G 10.	3.5	10.	Ground oats, ground barley, corn feed meal, wheat meal, ground corn bran, cottonseed meal, salt one-half of one per ct.
			F 10.9	3.5	6.1	Crushed oats, crushed barley, corn feed meal, ground corn bran, ground corn offal, wheat meal, cottonseed meal, salt.

0182	The Albert Dickinson Co., Chicago, Ill. "Dickinson's Globe Developing Feed"	Newburgh	G 10.	2.5	5.	Corn, wheat, kaffir corn, hulled oats and millet.
			F 10.3	3.7	3.	Cracked corn, wheat, kaffir corn, hulled oats, millet, approximately 3.2 per ct. buckwheat.
7385	Dock & Coal Co., Plattsburg, N. Y. "Dandy Feed"	Plattsburg	G 8.	5.	8.	Corn meal and oat midds, oats and oat hulls.
			F 9.9	5.3	4.2	Corn feed meal, oats, oat hulls, oat middlings.
8540	R. D. Eaton Grain & Feed Co., Norwich, N. Y. "Eaton's Special Dairy Feed"	Norwich	G 12.	3.	12.	Buckwheat and kaffir corn meal, alfalfa meal, linseed oil meal, pea meal, brewers' grain, corn meal, cottonseed meal, oats and barley.
			F 11.9	4.4	6.6	Ground oats, barley, kaffir corn and buckwheat, alfalfa meal, linseed meal, pea meal, brewers' dried grains, corn meal, cottonseed meal.
8452	Edwards & Loomis Co., Chicago, Ill. "Pioneer Feed"	Geneva	G 10.	2.5	9.	Corn feed meal, oat feed, wheat middlings, wheat bran, corn gluten feed.
			F 10.2	3.	8.2	Corn feed meal, oat hulls, oat middlings, wheat bran, wheat middlings, corn gluten feed.
7129	Elmore Milling Co., Oneonta, N. Y. "Elmore Milk Grains"	Stamford	G 25.	6.	10.	Corn distillers' dried grains, 41 per ct. cottonseed meal, corn gluten feed, hominy meal, choice wheat bran, barley, malt sprouts, dried brewers' grains, a little fine table salt, old process linseed meal.
			F 26.6	6.8	9.5	Distillers' dried grains, cottonseed meal, corn gluten feed, hominy meal, wheat bran, barley, malt sprouts, brewers' dried grains, linseed meal, salt.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
8828	Elmore Milling Co., Oneonta, N. Y "Elmore's Stock Feed"	Ballston Spgs.	G* 10.	4.	12.	Corn, meal, hominy, dried brewers' grain, wheat bran, oat meal mill by-product (oat middlings, oat shorts, oat hulls), salt.
			F* 9.8	3.8	10.9	As certified.
7864	Empire Grain & Elevator Co., Binghamton, N. Y. "Egee Stock Feed"	Apulia Station	G 10.	4.50	12.	Hominy feed, maizo corn oil meal, maizo red dog flour, oat meal mill by-product (oat middlings, oat hulls, oat shorts), and salt.
			F 11.	6.5	8.1	Hominy feed, corn germ meal, white corn flour, oat middlings, oat shorts, oat hulls, trace of salt.
7341	The Empire Mfg. Co. Franklinville, N. Y. "Empire Stock Feed"	Franklinville	G 20.	3.	8.	Malt sprouts, wheat bran, corn, cottonseed meal, gluten, oil meal, distillers' grains, salt.
			F 23.4	4:5	8.9	Wheat bran, malt sprouts, cottonseed meal, ground corn, corn gluten feed, linseed meal, distillers' dried grains, salt.
7857	Empire Mills, Olean, N. Y. "Empire Feed"	McGrawville	G 7.5	3.	9.	Corn, hominy, oat hulls.
			F 9.1	3.9	6.8	Ground corn, hominy feed, oat hulls.
0369	Empire Mill & Coal Co., Schaghticoke, N. Y. "Empire Milk Producer"	Schaghticoke	G 14.5	2.4	10.5	Corn meal, wheat bran, rye feed, cottonseed, Onyx dried grains, ground screening from rye, oats and corn, mill sweepings, fine salt.
			F 18.9	5.2	8.5	Corn meal, wheat bran, rye bran, rye middlings, cottonseed meal, yeast or vinegar dried grains, ground screenings from rye, oats and corn, salt.

8604	Empire Stock & Poultry Food Co., Auburn, N. Y. "Empire Stock Regulator"	Auburn	G	23.5	7.3	18.3	Sulphur, gentiana, lutea, sem. fenugreek, sem. anise, pulv. capsicum, oil meal, pulv. carbo lig., sod. chlorid.
			F	24.4	7.6	15.7	Linseed oil meal, sulphur, gentian, fenugreek, anise, capsicum, charcoal, salt.
069	Federal Milling Co., Lockport, N. Y. "Lucky Oat-Corn Feed"	Lockport	G	8.	3.	8.	Crushed oats, cracked corn, corn feed meal, hominy feed.
			F	10.4	5.3	5.3	As certified.
7966	Federal Milling Co., Lockport, N. Y. "Lucky Oat-Corn Feed"	Spencerport	G	9.	3.	8.	Crushed oats, corn feed meal, hominy feed and cracked corn.
			F	11.2	3.2	6.1	As certified.
7885	General Flour & Feed Co., Buffalo, N. Y. "Banner Horse Feed"	Syracuse	G	7.	2.5	13.5	Corn feed meal, ground oats, cracked corn, oat clippings, oat middlings, ground oat hulls, salt, linseed meal.
			F	8.4	2.7	13.1	Cracked corn, corn feed meal, ground oats, oat middlings, oat hulls, clipped oat by-products, linseed meal, salt.
7828	General Flour & Feed Co., Buffalo, N. Y. "Honest Cow Feed"	Syracuse	G	24.	6.	9.	Distillers' dried grains, corn gluten feed, wheat middlings, corn meal, wheat bran, one per ct. salt, corn bran, cottonseed meal, linseed meal.
			F	25.3	6.7	9.	As certified.
077	J. Gorman, Buffalo, N. Y. "Boat Sweepings"	Buffalo	G	5.	2.	14.	Sweepings from boats loaded with flour and feed and consists of several materials having feeding stuffs value, but impossible to name each ingredient contained therein.
			F	16.	4.2	6.	Wheat bran, wheat middlings, wheat flour, corn meal, linseed meal, corn gluten feed, distillers' dried grains, alfalfa, barley, peas, wheat.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
8508	Gilbert & Nichols Co., Fulton, N. Y. "Fulton Dairy Feed"	Brewerton	G* 25.	5.	9.	Distillers' grains, malt sprouts, brewers' grains, cottonseed meal, old process oil meal, buckwheat middlings, gluten feed, wheat bran, corn meal and ground oats mixed with a very small quantity of salt.
			F* 27.5	5.5	8.7	Distillers' dried grains, malt sprouts, brewers' dried grains, cottonseed meal, linseed meal, buckwheat middlings, buckwheat hulls, corn gluten feed, wheat bran, corn meal, ground oats, salt.
075	Globe Elevator Co., Buffalo, N. Y. "Buffalo Dairy Mixed Feed"	Buffalo	G 12.	5.	9.	Wheat bran with ground screenings, corn bran, wheat flour, wheat middlings, salt three-fourths of one per ct.
			F 13.4	7.3	7.1	As certified.
8191	Globe Elevator Co., Buffalo, N. Y. "Buffalo Stock Feed"	Pawling	G 9.	4.	9.	Made from corn, barley, oats, red dog flour, oat hulls, oat middlings, hominy feed, cottonseed meal, salt three-fourths of one per ct.
			F 10.4	4.	6.3	Ground corn, oats and barley, red dog flour, oat hulls, oat middlings, yellow hominy feed, cottonseed meal, salt.

8332	Globe Elevator Co., Buffalo, N. Y. "Globe Creamery Feed"	Blossvale	G	23.	5.	9.	Rye and corn distillers' dried grains, brewers' dried grains, dried beet pulp, cottonseed meal, linseed oil meal, clipped oat by-product, wheat bran and middlings with ground screenings, salt one-half of one per ct.
			F	22.7	4.9	12.1	Distillers' dried grains, brewers' dried grains, dried beet pulp, cottonseed meal, linseed meal, corn gluten feed, oat hulls, wheat bran and wheat middlings with ground screenings, salt.
6375	D. H. Grandin Milling Co., Jamestown, N. Y. "Grandin's Stock Food"	Batavia	G	8.5	3.5	10.	Pure oats, corn, barley, barley middlings, hominy feed, oat hulls and salt.
			F	9.9	7.	10.5	As certified.
084	Henry & Missert, Buffalo, N. Y. "B. S. Stock Food"	Buffalo	G	12.	2.	14.	Ground wheat screenings and sweepings from boats loaded with flour and feed consisting of various materials having feeding value, but impossible to name each ingredient therein.
			F	15.4	5.4	10.5	Ground wheat screenings, wheat bran, wheat middlings, wheat flour, corn, oats, barley, flaxseed, buckwheat, corn gluten feed.
7393	A. H. Herrick & Son, Watertown, N. Y. "Herrick's Corn and Oat Feed"	Watertown	G	9.	3.	13.	Ground corn and ground oats, small amount of ground barley and ground peas, corn feed meal.
			F	10.9	4.6	5.2	Ground corn, oats and barley, corn feed meal, traces of ground peas.
8743	Holdridge Milling Co., Randolph, N. Y. "Royal Milk Producer"	Randolph	G	25.	7.	11.	Hominy and corn meal, corn distillers' grains, forty-one per ct. cottonseed meal, fancy winter wheat bran, old process oil meal, fancy malt sprouts, corn gluten.
			F	25.4	6.4	8.1	Distillers' dried grains, corn meal, hominy feed, cottonseed meal, wheat bran, linseed meal, malt sprouts, corn gluten feed.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
7896	Hunter-Robinson-Wenz Milling Co., St. Louis, Mo.	Syracuse	G* 15.5	4.	10.	Wheat bran and middlings with ground screenings not exceeding mill run.
	" Matchless Heavy Mixed Feed "		F* 17.7	4.6	7.4	Wheat bran, wheat middlings, traces of ground screenings.
090	Hydraulic Milling Co., Buffalo, N. Y.	Buffalo	G 6.44	2.53	6.	Corn meal, hominy, oat middlings, oat hulls, ground oats.
	" Hydraulic Milling Company's Standard Chop Feed "		F 10.9	4.4	5.4	As certified.
7921	Jamestown Electric Mills, Jamestown, N. Y. " Jem Stock Feed "	Perry	G 10.	5.	10.	Ground corn, hominy feed, corn oil meal, ground oats, oat middlings, oat feed, small percentage of salt.
			F 11.2	6.3	10.2	Ground corn, hominy feed, corn germ meal, ground oats, oat middlings, oat hulls, salt.
8729	Jamestown Electric Mills, Jamestown, N. Y. " Purity Milk Maker "	Frewsburg	G 22.	7.	11.	Distillers' dried grains, brewers' dried grains, wheat bran, wheat middlings, corn gluten feed, cottonseed meal, linseed oil meal, corn meal, malt sprouts and small percentage of fine salt.
			F 24.5	8.1	9.2	As certified.

8324	Fred M. Kenyon, Williamson, N. Y. "Supreme Dairy Feed"	Hannibal	G 25.	6.	12.	Forty-one per ct. cottonseed meal, gluten feed (made from corn), distillers' dried grains, dried brewers' grains, fancy malt sprouts, corn meal and hominy, choice wheat bran, old process oil meal, or small quantity of flaxseed meal, salt three-fourths of one per ct.
			F 26.7	6.1	9.9	Cottonseed meal, corn gluten feed, distillers' dried grains, brewers' dried grains, malt sprouts, corn meal, hominy feed, wheat bran, linseed meal, salt.
7792	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Stock Feed"	Poland	G 10.	4.5	12.	Hominy feed, maizo corn oil meal, maizo red dog flour, oat meal mill by-products, oat middlings, oat hulls, oat shorts, salt.
			F 10.5	4.6	6.9	Hominy feed, corn germ meal, white corn flour, oat middlings, oat shorts, oat hulls, salt.
9017	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Wheat Middlings and Maizo Red Dog Flour"	Goshen	G 12.	4.5	7.	Maizo red dog flour, wheat middlings with ground wheat screenings, not exceeding mill run.
			F 12.8	7.1	4.	White corn flour, wheat middlings containing a small amount of ground screenings.
0176	Labar & Lain, Port Jervis, N. Y. "Horse Feed"	Port Jervis	G 6.5	3.	12.	Ground corn and oats, oat middlings, oat hulls and corn bran.
			F 9.6	3.9	6.3	As certified.
8818	Lapham & Parks, Glens Falls, N. Y. "Corn, Oat and Rye Feed"	Glens Falls	G 11.7	3.9	5.7	Ground corn, oats and rye, ground corn cob.
			F 11.9	3.	6.	As certified.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*	
7093	Tioga Mill & Elevator Co., Waverly, N. Y. "Derby Stock Feed"	Hancock	G* 10.5	4.	13.25	Corn offal, hominy, corn gluten feed, oat middlings, oat hulls.
			F* 13.8	5.4	10.3	As certified.
0197	Tioga Mill & Elevator Co., Waverly, N. Y. "Economy Feed"	Watervliet	G 9.7	4.	17.25	Hominy, brewers' grains, corn offal, cob meal, oat hulls, oat middlings.
			F 10.8	4.5	15.7	As certified.
7917	George Tomlinson & Son, Perry, N. Y. "Chop Feed"	Perry	G 11.31	4.51	4.59	Corn, oat and bran.
			F 11.8	4.8	6.1	Ground corn and oats, wheat bran.
7932	The Ubiko Milling Co., Cincinnati, O. "Union Grains, Ubiko, Biles Ready Dairy Ration"	Hornell	G 24.	7.	9.	Fourex distillers' dried grains, choice cottonseed meal, old process linseed meal, white wheat middlings, winter wheat bran, hominy meal, barley malt sprouts, one-half per ct. of fine table salt.
			F 24.6	6.1	9.2	As certified.
7326	The Ubiko Milling Co., Cincinnati, O. "Ubiko Horse and Stock Feed"	Ellicottville	G 16.	6.	9.	Wheat middlings, hominy meal, wheat bran, brewers' dried grains, old process linseed meal.
			F 17.2	7.2	7.9	Wheat bran, wheat middlings, hominy meal, brewers' dried grains, linseed meal.
7140	E. T. Van Buren, Hobart, N. Y. "Horse Feed No. 2"	Hobart	G 11.	4.	5.	Contains corn, oats, barley, mixed wheat feed.
			F 13.3	4.	5.3	Ground corn, oats and barley, wheat bran, wheat middlings.

8310	Harvey T. Matson, Crockett, N. Y. " Dairy Feed "	Crockett	G	——	——	——	Cottonseed meal, gluten feed, middlings, bran, distillers' grains, malt sprouts, corn meal, oat feed.
			F	24.8	4.9	11.3	Cottonseed meal, corn gluten feed, wheat bran, wheat middlings, brewers' dried grains, malt sprouts, corn meal, oat hulls, oat shorts, oat middlings.
0179	Matthews & Harrison, Kingston, N. Y. " Arcade Stock Feed "	Kingston	G	6.5	2.5	15.	Hominy feed, ground corn, wheat middlings, corn bran, oat feed, ground grain screenings and salt.
			F	11.6	5.	6.6	Ground corn, corn bran, hominy feed, wheat middlings, oats, ground screenings from wheat and oats, salt.
0178	Matthews & Harrison, Kingston, N. Y. " Colonial Stock Feed "	Kingston	G	7.5	3.5	14.	Ground corn, hominy feed, oat feed, oat hulls, wheat middlings, corn gluten feed and salt.
			F	11.	5.2	10.6	Ground corn, hominy feed, oat hulls, oat shorts, oat middlings, wheat middlings, corn gluten feed, salt.
0567	Mohawk Condensed Milk Co., Sherman, N. Y. " Mohawk Dairy Ration "	Sherman	G	22.5	6.3	10.85	Distillers' dried grains, choice cottonseed meal, old process linseed meal, wheat bran, choice corn meal, and nothing else.
			F	22.9	6.3	7.5	As certified.
8254	Morris Bros., Oneonta, N. Y. " Morris Special Dairy Feed "	Oneonta	G	24.1	6.1	9.8	Distillers' grains, cottonseed meal, linseed oil meal, malt sprouts, corn gluten feed, hominy feed, wheat bran, salt.
			F	26.4	6.5	9.5	As certified.
8320	Morris Bros., Oneonta, N. Y. " Morris Stock Feed "	Oneonta	G	10.	4.	12.	Corn meal, hominy, dried brewers' grains, wheat bran, oat meal mill by-products (oat hulls, oat middlings, oat shorts), salt.
			F	10.2	4.3	10.6	As certified.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
8222	Moses Bros., Eaton, N. Y. "Madison Stock Feed"	Clinton	G* 8.	3.	14.	Corn meal, oat midds, oat shorts, oat hulls (mill run from oat cereal plant), hominy, linseed meal, white wheat midds, and one-half of one per ct. salt.
			F* 10.8	2.6	11.7	Corn meal, oat middlings, oat shorts, oat hulls, hominy feed, linseed meal wheat white middlings, salt.
8470	John C. Murphy, Elmira, N. Y. "No. 2 Feed"	Elmira	G ——	——	——	Corn, oats, rye and buckwheat. Whole grains ground together.
			F 10.8	3.7	4.4	Ground corn, oats, rye and buckwheat.
0570	Nichols Brothers, Kennedy, N. Y. "Old Nick Milk Maker"	Kennedy	G 24.	5.25	12.	Distillers' grains, hominy feed, corn meal, cottonseed meal, wheat bran with ground screenings not exceeding mill run, linseed meal, barley malt sprouts, corn gluten feed.
			F 25.1	5.7	8.4	As certified.
6397	A. Nowak & Son, Buffalo, N. Y. "Buffalo Horse Feed"	Warsaw	G 7.	3.	12.	Ground oats, corn feed meal, hominy feed, oat hulls, clipped oat by-product, wheat middlings and three-fourths of one per ct. salt, containing some seeds.
			F 7.8	3.	13.3	Ground oats, corn feed meal, hominy feed, oat hulls, clipped oat by-product, wheat middlings, salt. Approximately 3.1 per ct. milo maize present.

8196	American Milling Co., Peoria, Ill. "Tip Top Sugared Feed"	Dover Plains	G	12.	2.5	12.	Ground and bolted grain screenings, molasses, clipped oat by-product, cottonseed meal and salt.
			F	12.3	4.5	11.9	As certified.
8603	Arcady Farms Milling Co., Rondout, Ill. "Arcady Dairy Feed"	Dryden	G	16.	3.5	15.	Made and processed from malt sprouts, dried brewers' grains, cottonseed meal molasses, ground and bolted clipped oat by-product, cleaned ground and bolted grain screenings, salt.
			F	15.6	3.7	12.8	As certified.
8529	Arcady Farm Milling Co., Rondout, Ill. "Arcady Horse Feed"	Binghamton	G	9.	2.	12.	Cracked corn, oats, alfalfa, molasses, one-half of one per ct. salt.
			F	9.8	2.3	10.5	Cracked corn, oats, alfalfa meal, molasses, salt.
7595	Arcady Farms Milling Co., Rondout, Ill. "Arcady Dairy Feed"	Mount Kisco	G	16.	3.5	15.	Malt sprouts, dried brewers' grains, cottonseed meal, cleaned, ground and bolted grain screenings, ground and bolted clipped oat by-product, molasses, one-half of one per ct. salt.
			F	14.7	4.5	12.	As certified.
8079	S. W. Bowne Co., Brooklyn, N. Y. "Faramel Horse Feed"	Brooklyn	G	9.	4.	6.	Oats, corn, wheat bran, molasses.
			F	9.5	3.4	5.6	Cracked corn, crushed oats, wheat bran, molasses.
8138	J. D. Braue, Inc., Jordan, N. Y. "Braue's Mixed Feed with Molasses"	Poughkeepsie	G	10.	2.	12.	Crushed oats, crushed corn and alfalfa meal, molasses.
			F	9.9	2.3	12.1	As certified.
7791	Geo. E. Brisbin & Co., Clyde, N. Y. "Blue Bell Dairy Feed"	Poland	G	16.	3.	15.	Cottonseed meal, malt sprouts, clipped oat by-product, ground and bolted grain screenings, molasses, one-half of one per ct. salt.
			F	16.4	4.	10.2	As certified.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
8303	George B. Palmer, Fulton, N. Y. "Dairy"	Fulton	G* ——	——	——	Gluten feed, cottonseed meal, brewers' grains, distillers' grains, Schumacher stock feed, bran.
			F* 21.6	4.9	8.	Corn gluten feed, cottonseed meal, brewers' dried grains, distillers' dried grains, linseed meal, ground corn, barley, hominy feed, wheat flour, oat middlings, oat hulls, salt.
7330	Phelps & Sibley, Cuba, N. Y. "White P & S Feed"	Cuba	G 7.	3.	8.	Ground white corn, hominy feed and oat hulls.
			F 9.5	4.	5.	As certified.
7329	Phelps & Sibley Co., Cuba, N. Y. "Yellow P & S Feed"	Cuba	G 7.	3.	9.	Corn meal, corn feed meal and oat hulls.
			F 9.2	3.8	6.	As certified.
7143	Park & Pollard Co., Boston, Mass. "Stock Feed"	Davenport Center	G 9.	3.	12.	Ground corn, hominy feed and oat feed.
			F 8.3	3.9	12.4	Ground corn, hominy feed, oats, oat shorts, oat middlings, oat hulls, salt.
6642	Edgar L. Potter, Fort Edward, N. Y. "Feed"	Fort Edward	G ——	——	——	Corn, oats, rye.
			F 10.7	4.2	5.3	Ground corn, oats, rye.
0351	Purity Oats Co., Davenport, Ia. "Iowa Stock Feed"	Schenectady	G 10.	4.	12.75	Wheat middlings, corn meal, hominy feed, brewers' dried grains, oat meal mill by-product (oat shorts, oat hulls, oat middlings) and one per ct. of table salt.
			F 9.8	4.4	8.3	As certified.

7572	The Quaker Oats Co., Chicago, Ill. "Boss Feed"	Yonkers	G	8.	3.	12.	Ground corn, hominy feed, oat meal, mill by-product, oat middlings, oat hulls, oat shorts, one-half of one per ct. salt.
			F	8.1	2.9	10.6	As certified.
8031	The Quaker Oats Co., Chicago, Ill. "Buckeye Feed"	Valley Stream	G	15.5	4.5	8.5	Wheat mixed feed with ground screenings not exceeding mill run and rye shorts.
			F	16.6	5.1	7.4	Wheat bran, wheat middlings, rye middlings, ground screenings.
0639	Quaker Oats Co., Chicago, Ill. "Schumacher Feed"	New York City	G	10.	3.25	10.	Ground corn, hominy feed, ground barley, wheat flour, wheat middlings with ground screenings not exceeding mill run, cottonseed meal, ground puffed rice, ground puffed wheat, oat meal mill by-product, oat middlings, oat hulls, oat shorts and one-half of one per ct. salt.
			F	10.8	4.2	10.6	As certified.
6371	The Quaker Oats Co., Chicago, Ill. "Schumacher F. S. Stock Feed"	Batavia	G	10.	3.25	10.	Ground corn, hominy feed, ground barley, wheat flour, wheat middlings with ground screenings not exceeding mill run, cottonseed meal, ground puffed rice, ground puffed wheat, oat meal mill by-product (oat hulls, oat middlings, oat shorts), one-fourth of one per ct. salt.
			F	11.3	5.	8.6	As certified.
7960	The Quaker Oats Co., Chicago, Ill. "Victor Feed"	Brockport	G	8.	3.	12.	Ground corn, hominy feed, oat meal mill by-product (oat middlings, oat hulls, oat shorts), one-half of one per ct. salt.
			F	9.9	5.3	9.2	As certified.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	Per ct.	Per ct.	
	COMPOUNDED FEEDS (*continued*):					
7331	The Quaker Oats Co., Chicago, Ill. "Vim Feed"	Cuba	G* 5.	2.	28.	Made from oat meal mill by-product (oat middlings, oat hulls, oat shorts).
			F* 7.1	2.2	25.	As certified.
8223	The Quaker Oats Co., Chicago, Ill. "White Diamond Feed"	New Hartford	G 8.	3.25	9.	Ground corn, hominy feed, oat meal mill by-product (oat middlings, oat hulls, oat shorts), and one-half of one per ct. salt.
			F 9.3	4.	7.9	As certified.
0168	John A. Reynolds, Albany, N. Y. "Peerless Milk Grains"	Albany	G 25.	6.	10.	Corn distillers' grains, old process oil meal, cottonseed meal, corn gluten feed, hominy feed, wheat bran, malt sprouts, dried brewers' grains, salt.
			F 26.6	5.8	9.2	As certified.
7600	John A. Reynolds, Albany, N. Y. "Peerless Stock Feed"	Chatham	G 10.	4.	12.	Corn meal, hominy, dried brewers' grains, wheat bran, oat hulls, oat middlings, oat shorts, salt.
			F 9.9	4.9	12.3	Corn meal, hominy feed, brewers' dried grains, wheat bran, oat hulls, oat shorts, oat middlings, salt.
6634	Saratoga Milling & Grain Co., Saratoga Spa, N. Y. "Horse Feed"	Saratoga Spa	G ——	——	——	Middlings, corn and oat screenings.
			F 10.5	4.0	6.	Ground corn and oats, wheat middlings, a small amount of screenings.
0657	Star Mills, D. W. Alsdorf, Prop., Little Valley, N. Y. "Star Dairy Feed"	Little Valley	G 18.	5.	12.	Wheat midds, hominy feed, corn meal, cottonseed meal, wheat bran with ground screenings not exceeding mill run, linseed meal, barley malt sprouts, corn gluten feed, brewers' grains.
			F 20.5	4.6	7.5	As certified.

8326	Stevens Milling & Feed Co., Inc., Lacona, N. Y. "Stevens Dairy Ration"	Lacona	G	24.	5.	14.	Made from old process linseed oil meal, cottonseed meal, cocoanut oil meal, distillers' dried grains, brewers' dried grains, malt sprouts, commercial wheat bran, pea meal, corn gluten meal, corn gluten feed, three-fourths of one per ct. salt.
			F	25.3	6.9	12.3	Cottonseed meal, linseed meal, cocoanut meal, distillers' dried grains, brewers' dried grains, malt sprouts, wheat bran, wheat middlings, pea meal, corn gluten meal, corn gluten feed, salt.
7942	J. H. Strait Milling Co., Canisteo, N. Y. "No. 2 Feed"	Canisteo	G	7.	5.	15.	Hominy, oat hulls, grain screenings and tolls from grist ground together.
			F	9.7	6.8	9.3	Hominy feed, oat hulls, ground oats, ground corn and grain screenings present in small amount.
0354	L. L. Streeter & Sons, Fonda, N. Y. "Adirondack Stock Feed"	Fonda	G	12.69	5.5	10.5	Hominy feed, corn feed meal, wheat flour middlings and wheat bran (with ground screenings not to exceed the mill run), ground white oats, ground barley, choice cottonseed meal, oat hulls and oat middlings, one-half of one per ct. salt.
			F	12.9	4.2	9.5	As certified.
7884	Syracuse Milling Co., Syracuse, N. Y. "Syragold Dairy Feed"	Clay	G	19.	5.	7.	Yellow corn meal, wheat bran, cottonseed meal, old process oil meal.
			F	20.3	5.7	7.	Wheat bran, wheat middlings, yellow corn meal, cottonseed meal, linseed meal, corn gluten feed, hominy feed.
8501	Syracuse Milling Co., Syracuse, N. Y. "Syragold Stock Feed"	Syracuse	G	10.	3.	12.	Ground corn, oats and barley, oat hulls, oat middlings, hominy, cottonseed meal and salt.
			F	11.	2.4	11.4	As certified.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS (*concluded*):					
7093	Tioga Mill & Elevator Co., Waverly, N. Y. "Derby Stock Feed"	Hancock	G* 10.5	4.	13.25	Corn offal, hominy, corn gluten feed, oat middlings, oat hulls.
			F* 13.8	5.4	10.3	As certified.
0197	Tioga Mill & Elevator Co., Waverly, N. Y. "Economy Feed"	Watervliet	G 9.7	4.	17.25	Hominy, brewers' grains, corn offal, cob meal, oat hulls, oat middlings.
			F 10.8	4.5	15.7	As certified.
7917	George Tomlinson & Son, Perry, N. Y. "Chop Feed"	Perry	G 11.31	4.51	4.59	Corn, oat and bran.
			F 11.8	4.8	6.1	Ground corn and oats, wheat bran.
7932	The Ubiko Milling Co., Cincinnati, O. "Union Grains, Ubiko, Biles Ready Dairy Ration"	Hornell	G 24.	7.	9.	Fourex distillers' dried grains, choice cottonseed meal, old process linseed meal, white wheat middlings, winter wheat bran, hominy meal, barley malt sprouts, one-half per ct. of fine table salt.
			F 24.6	6.1	9.2	As certified.
7326	The Ubiko Milling Co., Cincinnati, O. "Ubiko Horse and Stock Feed"	Ellicottville	G 16.	6.	9.	Wheat middlings, hominy meal, wheat bran, brewers' dried grains, old process linseed meal.
			F 17.2	7.2	7.9	Wheat bran, wheat middlings, hominy meal, brewers' dried grains, linseed meal.
7140	E. T. Van Buren, Hobart, N. Y. "Horse Feed No. 2"	Hobart	G 11.	4.	5.	Contains corn, oats, barley, mixed wheat feed.
			F 13.3	4.	5.3	Ground corn, oats and barley, wheat bran, wheat middlings.

7387	Vermont Cereal Co., Burlington, Vt. "Waumbeck Milk Maker Mixture"	Malone	G	23.	5.	12.	Dried malted grain, old process oil meal, pulverized grain screenings, one-half of one per ct. salt added.
			F	26.9	5.4	11.4	Brewers' dried grains, linseed oil meal, ground grain screenings consisting largely of weed seeds, salt.
8746	A. Waller & Co., Henderson, Ky. "Blue Grass Valley Feed"	Silver Creek	G	9.	2.	17.	Winter wheat bran, winter wheat middlings, ground corn and cob.
			F	10.6	2.8	15.1	As certified.
6635	Daniel Washburn Est., Gansevoort, N. Y. "Horse Feed"	Gansevoort	G	——	——	——	Corn, oats, rye, wheat.
			F	10.	3.7	3.2	Ground corn, oats, wheat, rye and a small amount of buckwheat.
7560	Westchester Grain Co., Port Chester, N. Y. "Corn, Oat and Chop Feed"	Port Chester	G	9.	4.25	10.	Corn meal, ground oats, reground oat hulls, corn bran.
			F	8.9	3.6	6.4	As certified.
087	Wollenberg Bros., Buffalo, N. Y. "W. B. Stock Feed"	Buffalo	G	8.	3.5	10.	Oats, corn, wheat middlings, oat clippings, salt.
			F	11.9	4.2	6.7	Ground corn, oats, oat clippings, light oats and screenings, wheat middlings, milo maize, ground peas, salt.
7364	Not given	Deer River	G	——	——	——	Hominy, bran, malt sprouts, Crown brewers' grains, 41 per ct. cottonseed, old process oil meal.
			F	21.6	6.6	8.5	Wheat bran, hominy feed, malt sprouts, brewers' dried grains, cottonseed meal, linseed meal, salt.
	COMPOUNDED FEEDS, MOLASSES:						
7567	Alfocorn Milling Co., East St. Louis, Ill. "Diamond D Dairy Feed"	Port Chester	G	16.	4.	11.	Cottonseed meal, wheat bran, hominy feed meal, alfalfa meal, and molasses.
			F	18.8	3.6	8.4	Cottonseed meal, wheat bran, corn feed meal, alfalfa meal, molasses.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
7565	Alfocorn Milling Co., East St. Louis, Ill. "Leader Horse & Mule Feed"	Port Chester	G* 9.	1.5	18.	Alfalfa meal, oats, corn and molasses.
			F* 8.5	1.5	11.6	Cracked corn, whole oats, alfalfa meal, molasses.
0649	American Hominy Co., Indianapolis, Ind. "Homco Horse Feed"	New York City	G 8.	2.5	11.	Cracked corn, rolled oats, alfalfa and molasses.
			F 8.9	2.2	8.5	As certified.
0650	American Hominy Co., Indianapolis, Ind. "Homco Superior Feed"	New York City	G 8.	2.9	7.5	Cracked corn, rolled oats, alfalfa, molasses.
			F 8.7	2.8	5.6	As certified.
7130	American Milling Co., Peoria, Ill. "Sucrene Dairy Feed"	Stamford	G 16.50	3.5	12.	Molasses, cottonseed meal, corn gluten feed, ground and bolted grain screenings, clipped oat by-product, linseed meal and salt.
			F 15.8	4.7	11.7	As certified.
0252	American Milling Co., Peoria, Ill. "Sucrene Horse Feed"	Gouverneur	G 9.	2.5	12.	Compounded with molasses, clipped oat by-product, corn, oats and salt.
			F 8.8	3.5	8.	As certified.
9012	American Milling Co., Peoria, Ill. "Sucrene Horse Feed with Alfalfa"	Middletown	G 10.	2.5	12.	Molasses, alfalfa, corn, oats, barley and salt.
			F 9.3	2.4	10.	Cracked corn, crushed oats, and barley, alfalfa meal, molasses, salt.
8544	American Milling Co., Peoria, Ill. "Sucrene Stock Feed"	Binghamton	G 10.	3.50	12.	Molasses, cracked corn, oats, barley, germ oil meal, oat feed and salt.
			F 12.1	5.9	8.	Cracked corn, oats, barley, corn germ meal, alfalfa meal, oat shorts, oat middlings, oat hulls, molasses, salt.

8196	American Milling Co., Peoria, Ill. "Tip Top Sugared Feed"	Dover Plains	G	12.	2.5	12.	Ground and bolted grain screenings, molasses, clipped oat by-product, cottonseed meal and salt.
			F	12.3	4.5	11.9	As certified.
8603	Arcady Farms Milling Co., Rondout, Ill. "Arcady Dairy Feed"	Dryden	G	16.	3.5	15.	Made and processed from malt sprouts, dried brewers' grains, cottonseed meal molasses, ground and bolted clipped oat by-product, cleaned ground and bolted grain screenings, salt.
			F	15.6	3.7	12.8	As certified.
8529	Arcady Farm Milling Co., Rondout, Ill. "Arcady Horse Feed"	Binghamton	G	9.	2.	12.	Cracked corn, oats, alfalfa, molasses, one-half of one per ct. salt.
			F	9.8	2.3	10.5	Cracked corn, oats, alfalfa meal, molasses, salt.
7595	Arcady Farms Milling Co., Rondout, Ill. "Arcady Dairy Feed"	Mount Kisco	G	16.	3.5	15.	Malt sprouts, dried brewers' grains, cottonseed meal, cleaned, ground and bolted grain screenings, ground and bolted clipped oat by-product, molasses, one-half of one per ct. salt.
			F	14.7	4.5	12.	As certified.
8079	S. W. Bowne Co., Brooklyn, N. Y. "Faramel Horse Feed"	Brooklyn	G	9.	4.	6.	Oats, corn, wheat bran, molasses.
			F	9.5	3.4	5.6	Cracked corn, crushed oats, wheat bran, molasses.
8138	J. D. Braue, Inc., Jordan, N. Y. "Braue's Mixed Feed with Molasses"	Poughkeepsie	G	10.	2.	12.	Crushed oats, crushed corn and alfalfa meal, molasses.
			F	9.9	2.3	12.1	As certified.
7791	Geo. E. Brisbin & Co., Clyde, N. Y. "Blue Bell Dairy Feed"	Poland	G	16.	3.	15.	Cottonseed meal, malt sprouts, clipped oat by-product, ground and bolted grain screenings, molasses, one-half of one per ct. salt.
			F	16.4	4.	10.2	As certified.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
6505	Geo. E. Brisbin & Co., Clyde, N. Y. " Blue Bell Dairy Feed "	South Berlin	G* 16.	3.	15.	Cottonseed meal, malt sprouts, clipped oat by-product, ground and bolted grain screenings, molasses and one-half of one per ct. salt.
			F* 15.8	5.	11.2	Cottonseed meal, malt sprouts, clipped oat by-product, ground grain screenings, molasses, salt.
6506	Geo. E. Brisbin & Co., Clyde, N. Y. " Blue Bell Dairy Feed "	South Berlin	G 16.	3.	15.	Cottonseed-meal, malt sprouts, clipped oat by-product, ground and bolted grain screenings, molasses and one-half of one per ct. salt.
			F 15.2	3.6	7.7	Cottonseed meal, malt sprouts, clipped oat by-product, ground grain screenings containing a rather large amount of weed seeds, molasses, salt.
8071	Brooklyn Elevator & Milling Co., Brooklyn, N. Y. " Bemco Feed "	Brooklyn	G 9.	2.	15.	Corn, oats, alfalfa, molasses.
			F 10.8	2.3	9.7	Cracked corn, crushed oats, alfalfa meal, molasses.
0378	Buffalo Cereal Co., Buffalo, N. Y. " Iroquois Dairy Feed "	Middletown	G 17.	4.	10.	Ground corn, corn gluten feed, cottonseed meal, ground grain screenings, molasses, one-half of one per ct. salt.
			F 16.4	3.2	10.7	As certified.
8569	Buffalo Cereal Co., Buffalo, N. Y. " Iroquois Horse Feed "	Greene	G 9.	2.	11.	Ground corn and oats, crushed oats, alfalfa meal, oat middlings, oat hulls, oat shorts and molasses.
			F 9.4	2.5	9.6	As certified.

0173	Buffalo Cereal Co., Buffalo, N. Y. "Iroquois Stock Feed"	Goshen	G	8.	3.	11.	Ground corn and oats, corn gluten feed, ground grain screenings, oat middlings, oat hulls, oat shorts and molasses.
			F	9.6	4.	8.8	As certified.
6647	Chapin & Co., Hammond, Ind. "Lactola Dairy Feed"	Greenwich	G	16.5	3.	12.	Choice cottonseed meal, corn distillers' grains, clipped oat by-products, corn gluten feed, corn germ meal, brewers' grains, palm nut meal, cane molasses, salt.
			F	16.9	3.8	9.4	Cottonseed-meal, distillers' dried grains, clipped oat by-product containing oat hulls, corn gluten feed, corn germ meal, brewers' dried grains, palm-nut meal, molasses, salt.
6388	Chesbro Bros., Attica, N. Y. "Molasses Screening Feed"	Attica	G	10.	5.	10.	Grain screenings and molasses.
			F	12.9	5.8	10.3	Ground grain screenings, molasses.
8466	Chesbro Milling Co., Salamanca, N. Y. "Wheelock's Horse Feed"	Elmira	G	10.	3.	12.	Cracked corn, crushed oats, wheat bran, molasses and a small percentage of salt.
			F	10.	3.2	3.3	As certified.
7789	Chippewa Feed & Grain Co., Inc., Buffalo, N. Y. "Chippewa Dairy Feed"	Phoenix	G	16.5	8.	12.	Cottonseed-meal, malt sprouts, alfalfa meal, ground screenings from corn, oats, wheat and barley, cane molasses and salt.
			F	16.8	4.9	10.5	Cottonseed meal, brewers' dried grains alfalfa meal, ground grain screenings molasses, salt.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
7113	Clover Leaf Milling Co., Buffalo, N. Y. "Clover Leaf Dairy Feed"	Roxbury	G* 16.5	3.5	12.	Cottonseed meal, gluten feed (corn), mixed broken grains consisting of wheat, corn, barley, flax, speltz, ground grain screenings, clipped oat by-product, molasses and a small percentage of salt.
			F* 20.1	4.5	11.1	Cottonseed meal, clipped oat by-product, ground grain screenings, molasses, salt.
8439	Clover Leaf Milling Co., Buffalo, N. Y. "Peerless Horse Feed"	Geneseo	G 10.	2.	12.	Cracked corn, crushed oats, alfalfa meal, molasses and a small percentage of salt.
			F 9.1	1.8	12.	Cracked corn, whole oats, alfalfa meal, molasses, salt.
068	Clover Leaf Milling Co., Buffalo, N. Y. "Clover Leaf Horse Feed"	Albion	G 10.	2.	12.	Cracked corn, crushed oats, alfalfa meal, molasses and a small percentage of salt
			F 10.4	2.8	9.9	Cracked corn, whole oats, alfalfa meal, molasses, a trace of salt.
0161	The Corno Mills Co., St. Louis, Mo. "Corno Mills Sweet Feed"	Albany	G 10.	2.5	12.	Whole oats, cracked corn, ground alfalfa, cane molasses, cottonseed meal, oat middlings, oat shorts, oat hulls.
			F 10.5	2.7	12.3	As certified.
8451	Edwards & Loomis Co., Chicago, Ill. "Greeno Feed"	Geneva	G 10.	0.5	26.	Alfalfa and molasses.
			F 14.1	0.6	15.	As certified.
8450	Edwards & Loomis Co., Chicago, Ill. "Harvest Horse Feed"	Geneva	G 10.	2.	15.	Alfalfa, molasses, cracked corn, barley and oats.
			F 12.	1.5	10.2	As certified.

8514	Empire Grain & Elevator Co., Binghamton, N. Y. "Egee Dairy Feed"	Afton	G 16.	2.	15.	Made from cottonseed meal, malt sprouts, ground and bolted screenings from wheat, oats and flax, one-fourth of one per ct. salt and molasses.
			F 17.2	3.7	13.3	As certified.
8524	Empire Grain & Elevator Co., Binghamton, N. Y. "Egee Horse Feed"	Whitney Point	G 10.	1.	12.	Corn, oats, alfalfa meal, salt and molasses.
			F 9.7	1.7	9.8	Cracked corn, crushed oats, alfalfa meal, molasses and salt.
0622	Excello Feed Milling Co., St. Joseph, Mo. "Excello Horse Feed"	New York City	G 10.	3.	15.	Alfalfa meal, corn chops, crushed oats, molasses, linseed meal and salt.
			F 10.5	2.7	9.3	As certified.
8502	Faramel Mfg. Co., Buffalo, N. Y. "Boggs Ceramel Horse Feed"	Syracuse	G 8.	2.	8.	Oats, corn, barley, wheat bran and molasses.
			F 8.1	2.6	6.	Cracked corn, crushed oats and barley, wheat bran, molasses.
8438	Faramel Mfg. Co., Buffalo, N. Y. "Faramel Alpha Horse Feed"	Dansville	G 9.	2.	12.5	Oats, corn, alfalfa and molasses.
			F 8.5	2.1	12.6	Cracked corn, crushed oats, alfalfa meal, molasses.
6383	Faramel Mfg. Co., Buffalo, N. Y. "Faramel Dairy Feed"	Attica	G 22.	3.	9.	Brewers' dried grains, corn gluten feed, linseed oil meal, wheat bran, molasses, one per ct. of salt.
			F 22.2	4.6	8.1	As certified.
7904	Faramel Mfg. Co., Buffalo, N. Y. "Faramel Horse Feed"	Warsaw	G 9.	4.	6.	Corn, oats, wheat bran and molasses.
			F 9.7	3.9	4.5	Crushed oats, cracked corn, wheat bran, molasses.
062	Faramel Mfg. Co., Buffalo, N. Y. "Nutrimel Dairy Feed"	Darien Center	G 18.	4.	12.	Brewers' grains, ground cleaned grain screenings, cottonseed meal, molasses, and one per ct. salt.
			F 19.5	5.2	12.	Brewers' dried grains, cottonseed meal, ground screenings from wheat, oats and flaxseed, molasses, salt.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.		Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):			*Per ct.*	*Per ct.*	*Per ct.*	
0573	The Gates Elevator Co., Cleveland, O. "Gates Quality Horse Feed"	Randolph	G*	10.	5.	5.	Cracked corn, rolled oats, wheat bran, cane molasses and salt.
			F*	10.	5.1	6.8	As certified.
8703	Globe Elevator Co., Buffalo, N. Y. "Anchor Horse Feed"	Buffalo	G	9.	3.	9.	Crushed and ground oats, ground and cracked corn, corn bran, wheat bran, crushed barley, molasses.
			F	10.	2.2	5.1	Crushed oats, ground oats, cracked corn, ground corn, corn bran, wheat bran, molasses, barley present in very small amount.
8443	Globe Elevator Co., Buffalo, N. Y. "Blue Ribbon Alfalmo Horse Feed"	Rochester	G	———	———	———	
			F	8.6	2.2	10.3	Cracked corn, crushed oats, alfalfa meal, molasses, salt.
8434	Globe Elevator Co., Buffalo, N. Y. "Blue Ribbon Horse Feed"	Bath	G	9.	2.	14.	Cracked corn, crushed oats, shredded alfalfa, molasses and salt three-fourths of one per ct.
			F	9.7	2.6	10.6	Cracked corn, crushed oats, alfalfa meal, molasses, salt.
8077	Globe Molasses Feed Co., Brooklyn, N. Y. "Crown Horse Feed"	Brooklyn	G	8.	1.65	10.48	Crushed oats, oat hulls, cracked corn, cane molasses.
			F	7.6	2.9	9.2	As certified.
8074	Globe Molasses Feed Co., Brooklyn, N. Y. "Globe Horse Feed"	Brooklyn	G	4.05	.25	13.25	Whole grain screenings, ground oats, cane molasses.
			F	6.7	1.7	12.9	As certified.

[illegible]	[illegible] Feed Co., Brooklyn, N. Y. "Shamrock"	Brooklyn	G	9.13	1.47	14.76	Alfalfa meal, cracked corn, cane molasses.
			F	9.5	1.7	15.	As certified.
8076	Globe Molasses Feed Co., Brooklyn, N. Y. "U. S. Horse Feed"	Brooklyn	G	7.	1.65	12.35	Cracked corn, whole grain screenings, cane molasses.
			F	6.9	2.6	8.5	As certified.
8059	Golden Grain Milling Co., East St. Louis, Mo. "Golden Grain Horse and Mule Feed"	Jamaica	G	10.	2.	12.	Corn, oats, alfalfa, molasses and one-half of one per ct. salt.
			F	10.	2.5	8.5	Cracked corn, oats, alfalfa meal, molasses, salt.
0641	Golden Grain Milling Co., East St. Louis, Ill. "Puritan Horse and Mule Feed"	New York City	G	9.	1.5	14.	Corn, oats, alfalfa, molasses and one-half of one per ct. salt.
			F	11.3	1.5	11.7	Cracked corn, whole oats, alfalfa meal, molasses, salt.
0625	Dwight E. Hamlin, Pittsburg, Pa. "Hamlin's Quality Feed"	New York City	G	9.	2.	10.	Corn, oats, alfalfa and cane syrup.
			F	9.9	3.1	8.2	Crushed corn, crushed oats, alfalfa meal, linseed meal, molasses.
8038	The H-O Co., Buffalo, N. Y. "The H-O Co's Algrane Horse Feed"	Valley Stream	G	11.	4.	10.	Crushed oats, oat shorts, ground corn, oat hulls, wheat middlings, hominy feed, corn gluten feed, salt one half of one per ct., molasses, ground grain screenings.
			F	11.7	4.2	9.	As certified.
078	The H-O Company, Buffalo, N. Y. "The H-O Co's Horse Feed with Molasses"	Buffalo	G	11.	4.	10.	Oats, oat shorts, ground corn, oat hulls, wheat midds, hominy feed, corn gluten feed, ground grain screenings, molasses, salt one half of one per ct.
			F	11.5	4.5	8.9	As certified.
7315	The H-O Company, Buffalo, N. Y. "The H-O Co's Algrane Milk Feed"	Buffalo	G	14.	4.	10.	Oat hulls, wheat midds, cottonseed meal, oat shorts, corn gluten feed, ground corn, ground oats, ground grain screenings, molasses, salt one-half of one per ct.
			F	18.	4.4	12.2	As certified.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*	
7093	Tioga Mill & Elevator Co., Waverly, N. Y. "Derby Stock Feed"	Hancock	G* 10.5	4.	13.25	Corn offal, hominy, corn gluten feed, oat middlings, oat hulls.
			F* 13.8	5.4	10.3	As certified.
0197	Tioga Mill & Elevator Co., Waverly, N. Y. "Economy Feed"	Watervliet	G 9.7	4.	17.25	Hominy, brewers' grains, corn offal, cob meal, oat hulls, oat middlings.
			F 10.8	4.5	15.7	As certified.
7917	George Tomlinson & Son, Perry, N. Y. "Chop Feed"	Perry	G 11.31	4.51	4.59	Corn, oat and bran.
			F 11.8	4.8	6.1	Ground corn and oats, wheat bran.
7932	The Ubiko Milling Co., Cincinnati, O. "Union Grains, Ubiko, Biles Ready Dairy Ration"	Hornell	G 24.	7.	9.	Fourex distillers' dried grains, choice cottonseed meal, old process linseed meal, white wheat middlings, winter wheat bran, hominy meal, barley malt sprouts, one-half per ct. of fine table salt.
			F 24.6	6.1	9.2	As certified.
7326	The Ubiko Milling Co., Cincinnati, O. "Ubiko Horse and Stock Feed"	Ellicottville	G 16.	6.	9.	Wheat middlings, hominy meal, wheat bran, brewers' dried grains, old process linseed meal.
			F 17.2	7.2	7.9	Wheat bran, wheat middlings, hominy meal, brewers' dried grains, linseed meal.
7140	E. T. Van Buren, Hobart, N. Y. "Horse Feed No. 2"	Hobart	G 11.	4.	5.	Contains corn, oats, barley, mixed wheat feed.
			F 13.3	4.	5.3	Ground corn, oats and barley, wheat bran, wheat middlings.

7387	Vermont Cereal Co., Burlington, Vt. "Waumbeck Milk Maker Mixture"	Malone	G	23.	5.	12.	Dried malted grain, old process oil meal, pulverized grain screenings, one-half of one per ct. salt added.
			F	26.9	5.4	11.4	Brewers' dried grains, linseed oil meal, ground grain screenings consisting largely of weed seeds, salt.
8746	A. Waller & Co., Henderson, Ky. "Blue Grass Valley Feed"	Silver Creek	G	9.	2.	17.	Winter wheat bran, winter wheat middlings, ground corn and cob.
			F	10.6	2.8	15.1	As certified.
6635	Daniel Washburn Est., Gansevoort, N. Y. "Horse Feed"	Gansevoort	G	——	——	——	Corn, oats, rye, wheat.
			F	10.	3.7	3.2	Ground corn, oats, wheat, rye and a small amount of buckwheat.
7560	Westchester Grain Co., Port Chester, N. Y. "Corn, Oat and Chop Feed"	Port Chester	G	9.	4.25	10.	Corn meal, ground oats, reground oat hulls, corn bran.
			F	8.9	3.6	6.4	As certified.
087	Wollenberg Bros., Buffalo, N. Y. "W. B. Stock Feed"	Buffalo	G	8.	3.5	10.	Oats, corn, wheat middlings, oat clippings, salt.
			F	11.9	4.2	6.7	Ground corn, oats, oat clippings, light oats and screenings, wheat middlings, milo maize, ground peas, salt.
7364	Not given	Deer River	G	——	——	——	Hominy, bran, malt sprouts, Crown brewers' grains, 41 per ct. cottonseed, old process oil meal.
			F	21.6	6.6	8.5	Wheat bran, hominy feed, malt sprouts, brewers' dried grains, cottonseed meal, linseed meal, salt.
	COMPOUNDED FEEDS, MOLASSES:						
7567	Alfocorn Milling Co., East St. Louis, Ill. "Diamond D Dairy Feed"	Port Chester	G	16.	4.	11.	Cottonseed meal, wheat bran, hominy feed meal, alfalfa meal, and molasses.
			F	18.8	3.6	8.4	Cottonseed meal, wheat bran, corn feed meal, alfalfa meal, molasses.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*	
7093	Tioga Mill & Elevator Co., Waverly, N. Y. "Derby Stock Feed"	Hancock	G* 10.5	4.	13.25	Corn offal, hominy, corn gluten feed, oat middlings, oat hulls.
			F* 13.8	5.4	10.3	As certified.
0197	Tioga Mill & Elevator Co., Waverly, N. Y. "Economy Feed"	Watervliet	G 9.7	4.	17.25	Hominy, brewers' grains, corn offal, cob meal, oat hulls, oat middlings.
			F 10.8	4.5	15.7	As certified.
7917	George Tomlinson & Son, Perry, N. Y. "Chop Feed"	Perry	G 11.31	4.51	4.59	Corn, oat and bran.
			F 11.8	4.8	6.1	Ground corn and oats, wheat bran.
7932	The Ubiko Milling Co., Cincinnati, O. "Union Grains, Ubiko, Biles Ready Dairy Ration"	Hornell	G 24.	7.	9.	Fourex distillers' dried grains, choice cottonseed meal, old process linseed meal, white wheat middlings, winter wheat bran, hominy meal, barley malt sprouts, one-half per ct. of fine table salt.
			F 24.6	6.1	9.2	As certified.
7326	The Ubiko Milling Co., Cincinnati, O. "Ubiko Horse and Stock Feed"	Ellicottville	G 16.	6.	9.	Wheat middlings, hominy meal, wheat bran, brewers' dried grains, old process linseed meal.
			F 17.2	7.2	7.9	Wheat bran, wheat middlings, hominy meal, brewers' dried grains, linseed meal.
7140	E. T. Van Buren, Hobart, N. Y. "Horse Feed No. 2"	Hobart	G 11.	4.	5.	Contains corn, oats, barley, mixed wheat feed.
			F 13.3	4.	5.3	Ground corn, oats and barley, wheat bran, wheat middlings.

7387	Vermont Cereal Co., Burlington, Vt. "Waumbeck Milk Maker Mixture"	Malone	G	23.	5.	12.	Dried malted grain, old process oil meal, pulverized grain screenings, one-half of one per ct. salt added.
			F	26.9	5.4	11.4	Brewers' dried grains, linseed oil meal, ground grain screenings consisting largely of weed seeds, salt.
8746	A. Waller & Co., Henderson, Ky. "Blue Grass Valley Feed"	Silver Creek	G	9.	2.	17.	Winter wheat bran, winter wheat middlings, ground corn and cob.
			F	10.6	2.8	15.1	As certified.
6635	Daniel Washburn Est., Gansevoort, N. Y. "Horse Feed"	Gansevoort	G	——	——	——	Corn, oats, rye, wheat.
			F	10.	3.7	3.2	Ground corn, oats, wheat, rye and a small amount of buckwheat.
7560	Westchester Grain Co., Port Chester, N. Y. "Corn, Oat and Chop Feed"	Port Chester	G	9.	4.25	10.	Corn meal, ground oats, reground oat hulls, corn bran.
			F	8.9	3.6	6.4	As certified.
087	Wollenberg Bros., Buffalo, N. Y. "W. B. Stock Feed"	Buffalo	G	8.	3.5	10.	Oats, corn, wheat middlings, oat clippings, salt.
			F	11.9	4.2	6.7	Ground corn, oats, oat clippings, light oats and screenings, wheat middlings, milo maize, ground peas, salt.
7364	Not given	Deer River	G	——	——	——	Hominy, bran, malt sprouts, Crown brewers' grains, 41 per ct. cottonseed, old process oil meal.
			F	21.6	6.6	8.5	Wheat bran, hominy feed, malt sprouts, brewers' dried grains, cottonseed meal, linseed meal, salt.
	Compounded Feeds, Molasses:						
7567	Alfocorn Milling Co., East St. Louis, Ill. "Diamond D Dairy Feed"	Port Chester	G	16.	4.	11.	Cottonseed meal, wheat bran, hominy feed meal, alfalfa meal, and molasses.
			F	18.8	3.6	8.4	Cottonseed meal, wheat bran, corn feed meal, alfalfa meal, molasses.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS, MOLASSES (*con.*):					
7565	Alfocorn Milling Co., East St. Louis, Ill. "Leader Horse & Mule Feed"	Port Chester	G* 9.	1.5	18.	Alfalfa meal, oats, corn and molasses.
			F* 8.5	1.5	11.6	Cracked corn, whole oats, alfalfa meal, molasses.
0649	American Hominy Co., Indianapolis, Ind. "Homco Horse Feed"	New York City	G 8.	2.5	11.	Cracked corn, rolled oats, alfalfa and molasses.
			F 8.9	2.2	8.5	As certified.
0650	American Hominy Co., Indianapolis, Ind. "Homco Superior Feed"	New York City	G 8.	2.9	7.5	Cracked corn, rolled oats, alfalfa, molasses.
			F 8.7	2.8	5.6	As certified.
7130	American Milling Co., Peoria, Ill. "Sucrene Dairy Feed"	Stamford	G 16.50	3.5	12.	Molasses, cottonseed meal, corn gluten feed, ground and bolted grain screenings, clipped oat by-product, linseed meal and salt.
			F 15.8	4.7	11.7	As certified.
0252	American Milling Co., Peoria, Ill. "Sucrene Horse Feed"	Gouverneur	G 9.	2.5	12.	Compounded with molasses, clipped oat by-product, corn, oats and salt.
			F 8.8	3.5	8.	As certified.
9012	American Milling Co., Peoria, Ill. "Sucrene Horse Feed with Alfalfa"	Middletown	G 10.	2.5	12.	Molasses, alfalfa, corn, oats, barley and salt.
			F 9.3	2.4	10.	Cracked corn, crushed oats, and barley, alfalfa meal, molasses, salt.
8544	American Milling Co., Peoria, Ill. "Sucrene Stock Feed"	Binghamton	G 10.	3.50	12.	Molasses, cracked corn, oats, barley, germ oil meal, oat feed and salt.
			F 12.1	5.9	8.	Cracked corn, oats, barley, corn germ meal, alfalfa meal, oat shorts, oat middlings, oat hulls, molasses, salt.

8196	American Milling Co., Peoria, Ill. "Tip Top Sugared Feed"	Dover Plains	G	12.	2.5	12.	Ground and bolted grain screenings, molasses, clipped oat by-product, cottonseed meal and salt.
			F	12.3	4.5	11.9	As certified.
8603	Arcady Farms Milling Co., Rondout, Ill. "Arcady Dairy Feed"	Dryden	G	16.	3.5	15.	Made and processed from malt sprouts, dried brewers' grains, cottonseed meal molasses, ground and bolted clipped oat by-product, cleaned ground and bolted grain screenings, salt.
			F	15.6	3.7	12.8	As certified.
8529	Arcady Farm Milling Co., Rondout, Ill. "Arcady Horse Feed"	Binghamton	G	9.	2.	12.	Cracked corn, oats, alfalfa, molasses, one-half of one per ct. salt.
			F	9.8	2.3	10.5	Cracked corn, oats, alfalfa meal, molasses, salt.
7595	Arcady Farms Milling Co., Rondout, Ill. "Arcady Dairy Feed"	Mount Kisco	G	16.	3.5	15.	Malt sprouts, dried brewers' grains, cottonseed meal, cleaned, ground and bolted grain screenings, ground and bolted clipped oat by-product, molasses, one-half of one per ct. salt.
			F	14.7	4.5	12.	As certified.
8079	S. W. Bowne Co., Brooklyn, N. Y. "Faramel Horse Feed"	Brooklyn	G	9.	4.	6.	Oats, corn, wheat bran, molasses.
			F	9.5	3.4	5.6	Cracked corn, crushed oats, wheat bran, molasses.
8138	J. D. Braue, Inc., Jordan, N. Y. "Braue's Mixed Feed with Molasses"	Poughkeepsie	G	10.	2.	12.	Crushed oats, crushed corn and alfalfa meal, molasses.
			F	9.9	2.3	12.1	As certified.
7791	Geo. E. Brisbin & Co., Clyde, N. Y. "Blue Bell Dairy Feed"	Poland	G	16.	3.	15.	Cottonseed meal, malt sprouts, clipped oat by-product, ground and bolted grain screenings, molasses, one-half of one per ct. salt.
			F	16.4	4.	10.2	As certified.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
6505	Geo. E. Brisbin & Co., Clyde, N. Y. "Blue Bell Dairy Feed"	South Berlin	G* 16.	3.	15.	Cottonseed meal, malt sprouts, clipped oat by-product, ground and bolted grain screenings, molasses and one-half of one per ct. salt.
			F* 15.8	5.	11.2	Cottonseed meal, malt sprouts, clipped oat by-product, ground grain screenings, molasses, salt.
6506	Geo. E. Brisbin & Co., Clyde, N. Y. "Blue Bell Dairy Feed"	South Berlin	G 16.	3.	15.	Cottonseed-meal, malt sprouts, clipped oat by-product, ground and bolted grain screenings, molasses and one-half of one per ct. salt.
			F 15.2	3.6	7.7	Cottonseed meal, malt sprouts, clipped oat by-product, ground grain screenings containing a rather large amount of weed seeds, molasses, salt.
8071	Brooklyn Elevator & Milling Co., Brooklyn, N. Y. "Bemco Feed"	Brooklyn	G 9.	2.	15.	Corn, oats, alfalfa, molasses.
			F 10.8	2.3	9.7	Cracked corn, crushed oats, alfalfa meal, molasses.
0378	Buffalo Cereal Co., Buffalo, N. Y. "Iroquois Dairy Feed"	Middletown	G 17.	4.	10.	Ground corn, corn gluten feed, cottonseed meal, ground grain screenings, molasses, one-half of one per ct. salt.
			F 16.4	3.2	10.7	As certified.
8569	Buffalo Cereal Co., Buffalo, N. Y. "Iroquois Horse Feed"	Greene	G 9.	2.	11.	Ground corn and oats, crushed oats, alfalfa meal, oat middlings, oat hulls, oat shorts and molasses.
			F 9.4	2.5	9.6	As certified.

0173	Buffalo Cereal Co., Buffalo, N. Y. "Iroquois Stock Feed"	Goshen	G	8.	3.	11.	Ground corn and oats, corn gluten feed, ground grain screenings, oat middlings, oat hulls, oat shorts and molasses.
			F	9.6	4.	8.8	As certified.
6647	Chapin & Co., Hammond, Ind. "Lactola Dairy Feed"	Greenwich	G	16.5	3.	12.	Choice cottonseed meal, corn distillers' grains, clipped oat by-products, corn gluten feed, corn germ meal, brewers' grains, palm nut meal, cane molasses, salt.
			F	16.9	3.8	9.4	Cottonseed-meal, distillers' dried grains, clipped oat by-product containing oat hulls, corn gluten feed, corn germ meal, brewers' dried grains, palm-nut meal, molasses, salt.
6388	Chesbro Bros., Attica, N. Y. "Molasses Screening Feed"	Attica	G	10.	5.	10.	Grain screenings and molasses.
			F	12.9	5.8	10.3	Ground grain screenings, molasses.
8466	Chesbro Milling Co., Salamanca, N. Y. "Wheelock's Horse Feed"	Elmira	G	10.	3.	12.	Cracked corn, crushed oats, wheat bran, molasses and a small percentage of salt.
			F	10.	3.2	3.3	As certified.
7789	Chippewa Feed & Grain Co., Inc., Buffalo, N. Y. "Chippewa Dairy Feed"	Phoenix	G	16.5	3.	12.	Cottonseed-meal, malt sprouts, alfalfa meal, ground screenings from corn, oats, wheat and barley, cane molasses and salt.
			F	16.8	4.9	10.5	Cottonseed meal, brewers' dried grains alfalfa meal, ground grain screenings molasses, salt.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
7113	Clover Leaf Milling Co., Buffalo, N. Y. "Clover Leaf Dairy Feed"	Roxbury	G* 16.5	3.5	12.	Cottonseed meal, gluten feed (corn), mixed broken grains consisting of wheat, corn, barley, flax, speltz, ground grain screenings, clipped oat by-product, molasses and a small percentage of salt.
			F* 20.1	4.5	11.1	Cottonseed meal, clipped oat by-product, ground grain screenings, molasses, salt.
8439	Clover Leaf Milling Co., Buffalo, N. Y. "Peerless Horse Feed"	Geneseo	G 10.	2.	12.	Cracked corn, crushed oats, alfalfa meal, molasses and a small percentage of salt.
			F 9.1	1.8	12.	Cracked corn, whole oats, alfalfa meal, molasses, salt.
068	Clover Leaf Milling Co., Buffalo, N. Y. "Clover Leaf Horse Feed"	Albion	G 10.	2.	12.	Cracked corn, crushed oats, alfalfa meal, molasses and a small percentage of salt
			F 10.4	2.8	9.9	Cracked corn, whole oats, alfalfa meal, molasses, a trace of salt.
0161	The Corno Mills Co., St. Louis, Mo. "Corno Mills Sweet Feed"	Albany	G 10.	2.5	12.	Whole oats, cracked corn, ground alfalfa, cane molasses, cottonseed meal, oat middlings, oat shorts, oat hulls.
			F 10.5	2.7	12.3	As certified.
8451	Edwards & Loomis Co., Chicago, Ill. "Greeno Feed"	Geneva	G 10.	0.5	26.	Alfalfa and molasses.
			F 14.1	0.6	15.	As certified.
8450	Edwards & Loomis Co., Chicago, Ill. "Harvest Horse Feed"	Geneva	G 10.	2.	15.	Alfalfa, molasses, cracked corn, barley and oats.
			F 12.	1.5	10.2	As certified.

8514	Empire Grain & Elevator Co., Binghamton, N. Y. "Egee Dairy Feed"	Afton	G 16.	2.	15.	Made from cottonseed meal, malt sprouts, ground and bolted screenings from wheat, oats and flax, one-fourth of one per ct. salt and molasses.
			F 17.2	3.7	13.3	As certified.
8524	Empire Grain & Elevator Co., Binghamton, N. Y. "Egee Horse Feed"	Whitney Point	G 10.	1.	12.	Corn, oats, alfalfa meal, salt and molasses.
			F 9.7	1.7	9.8	Cracked corn, crushed oats, alfalfa meal, molasses and salt.
0622	Excello Feed Milling Co., St. Joseph, Mo. "Excello Horse Feed"	New York City	G 10.	3.	15.	Alfalfa meal, corn chops, crushed oats, molasses, linseed meal and salt.
			F 10.5	2.7	9.3	As certified.
8502	Faramel Mfg. Co., Buffalo, N. Y. "Boggs Ceramel Horse Feed"	Syracuse	G 8.	2.	8.	Oats, corn, barley, wheat bran and molasses.
			F 8.1	2.6	6.	Cracked corn, crushed oats and barley, wheat bran, molasses.
8438	Faramel Mfg. Co., Buffalo, N. Y. "Faramel Alpha Horse Feed"	Dansville	G 9.	2.	12.5	Oats, corn, alfalfa and molasses.
			F 8.5	2.1	12.6	Cracked corn, crushed oats, alfalfa meal, molasses.
6383	Faramel Mfg. Co., Buffalo, N. Y. "Faramel Dairy Feed"	Attica	G 22.	3.	9.	Brewers' dried grains, corn gluten feed, linseed oil meal, wheat bran, molasses, one per ct. of salt.
			F 22.2	4.6	8.1	As certified.
7904	Faramel Mfg. Co., Buffalo, N. Y. "Faramel Horse Feed"	Warsaw	G 9.	4.	6.	Corn, oats, wheat bran and molasses.
			F 9.7	3.9	4.5	Crushed oats, cracked corn, wheat bran, molasses.
062	Faramel Mfg. Co., Buffalo, N. Y. "Nutrimel Dairy Feed"	Darien Center	G 18.	4.	12.	Brewers' grains, ground cleaned grain screenings, cottonseed meal, molasses, and one per ct. salt.
			F 19.5	5.2	12.	Brewers' dried grains, cottonseed meal, ground screenings from wheat, oats and flaxseed, molasses, salt.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
0573	The Gates Elevator Co., Cleveland, O. "Gates Quality Horse Feed"	Randolph	G* 10.	5.	5.	Cracked corn, rolled oats, wheat bran, cane molasses and salt.
			F* 10.	5.1	6.8	As certified.
8703	Globe Elevator Co., Buffalo, N. Y. "Anchor Horse Feed"	Buffalo	G 9.	3.	9.	Crushed and ground oats, ground and cracked corn, corn bran, wheat bran, crushed barley, molasses.
			F 10.	2.2	5.1	Crushed oats, ground oats, cracked corn, ground corn, corn bran, wheat bran, molasses, barley present in very small amount.
8443	Globe Elevator Co., Buffalo, N. Y. "Blue Ribbon Alfalmo Horse Feed"	Rochester	G ——	——	——	
			F 8.6	2.2	10.3	Cracked corn, crushed oats, alfalfa meal, molasses, salt.
8434	Globe Elevator Co., Buffalo, N. Y. "Blue Ribbon Horse Feed"	Bath	G 9.	2.	14.	Cracked corn, crushed oats, shredded alfalfa, molasses and salt three-fourths of one per ct.
			F 9.7	2.6	10.6	Cracked corn, crushed oats, alfalfa meal, molasses, salt.
8077	Globe Molasses Feed Co., Brooklyn, N. Y. "Crown Horse Feed"	Brooklyn	G 8.	1.65	10.48	Crushed oats, oat hulls, cracked corn, cane molasses.
			F 7.6	2.9	9.2	As certified.
8074	Globe Molasses Feed Co., Brooklyn, N. Y. "Globe Horse Feed"	Brooklyn	G 4.05	.25	13.25	Whole grain screenings, ground oats, cane molasses.
			F 6.7	1.7	12.9	As certified.

[illegible]	[illegible] Feed Co., Brooklyn, N. Y. "Shamrock"	Brooklyn	G	9.13	1.47	14.76	Alfalfa meal, cracked corn, cane molasses.
			F	9.5	1.7	15.	As certified.
8076	Globe Molasses Feed Co., Brooklyn, N. Y. "U. S. Horse Feed"	Brooklyn	G	7.	1.65	12.35	Cracked corn, whole grain screenings, cane molasses.
			F	6.9	2.6	8.5	As certified.
8059	Golden Grain Milling Co., East St. Louis, Mo. "Golden Grain Horse and Mule Feed"	Jamaica	G	10.	2.	12.	Corn, oats, alfalfa, molasses and one-half of one per ct. salt.
			F	10.	2.5	8.5	Cracked corn, oats, alfalfa meal, molasses, salt.
0641	Golden Grain Milling Co., East St. Louis, Ill. "Puritan Horse and Mule Feed"	New York City	G	9.	1.5	14.	Corn, oats, alfalfa, molasses and one-half of one per ct. salt.
			F	11.3	1.5	11.7	Cracked corn, whole oats, alfalfa meal, molasses, salt.
0625	Dwight E. Hamlin, Pittsburg, Pa. "Hamlin's Quality Feed"	New York City	G	9.	2.	10.	Corn, oats, alfalfa and cane syrup.
			F	9.9	3.1	8.2	Crushed corn, crushed oats, alfalfa meal, linseed meal, molasses.
8038	The H-O Co., Buffalo, N. Y. "The H-O Co's Algrane Horse Feed"	Valley Stream	G	11.	4.	10.	Crushed oats, oat shorts, ground corn, oat hulls, wheat middlings, hominy feed, corn gluten feed, salt one half of one per ct., molasses, ground grain screenings.
			F	11.7	4.2	9.	As certified.
078	The H-O Company, Buffalo, N. Y. "The H-O Co's Horse Feed with Molasses"	Buffalo	G	11.	4.	10.	Oats, oat shorts, ground corn, oat hulls, wheat midds, hominy feed, corn gluten feed, ground grain screenings, molasses, salt one half of one per ct.
			F	11.5	4.5	8.9	As certified.
7315	The H-O Company, Buffalo, N. Y. "The H-O Co's Algrane Milk Feed"	Buffalo	G	14.	4.	10.	Oat hulls, wheat midds, cottonseed meal, oat shorts, corn gluten feed, ground corn, ground oats, ground grain screenings, molasses, salt one-half of one per ct.
			F	18.	4.4	12.2	As certified.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
079	The H-O Company, Buffalo, N. Y. "The H-O Co's Horse Feed with Alfalfa"	Buffalo	G* 11.	3.	14.	Alfalfa meal, molasses, wheat midds, ground corn, corn gluten feed, oat hulls, ground grain screenings, oat shorts, salt one-half of one per ct.
			F* 12.1	3.6	10.5	As certified.
080	The H-O Company, Buffalo, N. Y. "The H-O Co's Jim Dandy Feed"	Buffalo	G 7.	2.5	25.	Oat hulls, oat shorts, molasses.
			F 7.	2.4	21.1	As certified.
7314	The H-O Company, Buffalo, N. Y. "The H-O Co's Milk Feed with Molasses"	Buffalo	G 14.	4.	10.	Oat hulls, wheat midds, cottonseed meal, oat shorts, corn gluten feed, ground corn, ground oats, ground grain screenings, molasses, one-half of one per ct. salt.
			F 17.2	4.1	12.8	As certified.
7316	The H-O Mills, Buffalo, N. Y. "The H-O Co's New England Stock Feed"	Buffalo	G 9.	4.	10.	Wheat middlings, ground corn, hominy feed, oat hulls, oat shorts, ground oats, ground grain screenings, molasses, salt one-half of one per ct.
			F 9.7	5.1	9.	As certified.
7317	The H-O Mills, Buffalo, N. Y. "The H-O Co's Vigor Feed"	Buffalo	G 12.5	4.	12.	Wheat bran, oat hulls, oat shorts, ground grain screenings, molasses.
			F 11.8	3.8	13.5	Wheat bran, wheat middlings, oat hulls, oat shorts, ground grain screenings, a small amount of molasses.

8740	Hudson Bros., Sanborn, N. Y. "Crown Horse Feed"	Lockport	G 8.	2.	9.	Crushed oats, cracked corn, wheat bran, feed meal, oat feed, molasses, small quantity of salt, barley.
			F 10.	3.2	6.2	As certified.
7945	International Sugar Feed Co., Minneapolis, Minn. "International Dairy Feed"	Canisteo	G 18.	3.5	12.	Cottonseed meal, molasses, ground clipped oat by-product, salt, ground cleaned grain screenings.
			F 18.6	5.9	10.9	Cottonseed meal, clipped oat by-product, ground grain screenings, molasses, a trace of salt.
7116	International Sugar Feed Co., Minneapolis, Minn. "International Climax Feed"	Roxbury	G 12.5	4.	12.	Cottonseed meal, molasses, ground grain screenings, ground clipped oat by-product, salt.
			F 12.8	5.1	12.1	Clipped oat by-product, ground grain screenings, cottonseed meal, molasses, salt.
7324	International Sugar Feed Co., Minneapolis, Minn. "International Special Dairy Feed"	Ellicottville	G 15.	4.5	12.	Cottonseed meal, molasses, ground clipped oat by-product, salt, ground cleaned grain screenings.
			F 15.6	5.2	10.9	Cottonseed meal, clipped oat by-product, ground grain screenings, molasses, salt.
8855	International Sugar Feed Co., Minneapolis, Minn. "International Special Dairy Feed"	Middleburgh	G 15.	4.5	12.	Cottonseed meal, molasses, ground clipped oat by-product, salt, ground cleaned grain screenings.
			F 15.1	5.	11.5	Cottonseed meal, clipped oat by-product, ground grain and flax screenings, molasses, salt.
0637	Kornfalfa Feed Milling Co., Kansas City, Mo. "Kay Horse & Mule Feed"	New York City	G 9.	1.5	15.	Alfalfa, corn, oats, molasses.
			F 10.4	1.	11.7	Cracked corn, crushed oats, alfalfa meal, molasses.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
7848	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Dairy Feed"	Georgetown Sta.	G* 16.	2.	15.	Cottonseed meal, malt sprouts, ground and bolted screenings from wheat and flax, one-fourth of one per ct. salt and molasses, oats.
			F* 16.7	4.7	11.	As certified.
7574	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Evergreen Feed"	Yonkers	G 12.	1.	30.	Made from alfalfa, molasses and salt.
			F 12.	0.9	13.9	Alfalfa meal, molasses, salt.
8036	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Horse Feed"	Valley Stream	G 10.	2.	12.	Corn, oats, alfalfa, molasses and salt.
			F 10.3	1.9	8.1	Cracked corn, crushed oats, alfalfa meal, molasses, salt.
8058	Chas. A. Krause Milling Co., Milwaukee, Wis. "Cream City Horse Feed"	Flushing	G 10.	1.5	14.	Alfalfa meal, molasses, corn, oats and salt.
			F 9.3	2.	10.2	Cracked corn, crushed oats, alfalfa meal, molasses, salt.
7575	Chas. A. Krause Milling Co., Milwaukee, Wis. "Derby Horse Feed"	Yonkers	G 10.	1.	16.	Corn, oats, alfalfa meal, molasses and salt.
			F 9.5	1.9	12.1	Cracked corn, crushed oats, alfalfa meal, molasses, salt.
067	The Lake Shore Elevator Co., Cleveland, O. "Faramel Horse Feed"	Albion	G 9.	4.	6.	Oats, corn, wheat bran and molasses.
			F 10.1	4.	5.7	Cracked corn, crushed oats, wheat bran, molasses.
066	The Lake Shore Elevator Co., Cleveland, O. "Alpha Horse Feed"	Albion	G ——	——	——	
			F 8.8	2.6	8.8	Cracked corn, crushed oats, alfalfa meal, molasses.

0388	Matthews & Harrison, Kingston, N. Y. "Ulster Horse Feed"	Kingston	G	9.	1.5	12.	Cracked corn, whole oats, gr. alfalfa, molasses and one per ct. salt.
			F	8.2	1.9	11.8	As certified.
8069	The Meader-Atlas Co., New York, N. Y. "Atlas Horse Feed"	Brooklyn	G	5.	1.	12.	Ground oats, corn and grain screenings, molasses, oat hulls, dried brewers' grains.
			F	5.1	1.4	8.8	As certified.
0603	The Meader-Atlas Co., New York, N. Y. "Ben Hur Horse Feed"	New York	G	9.	2.	15.	Cracked corn, whole oats, alfalfa meal and pure sugar cane molasses.
			F	8.1	1.6	11.	As certified.
0612	The Meader-Atlas Co., New York, N. Y. "Bowling Green Horse Feed"	Brooklyn	G	10.	2.	15.	Pure alfalfa meal, cracked corn, whole oats, sugar cane molasses.
			F	8.6	2.5	3.8	As certified.
8070	The Meader-Atlas Co., New York, N. Y. "Comal Horse Feed"	Brooklyn	G	9.	2.	15.	Cracked corn, whole oats, alfalfa meal, and pure sugar cane molasses.
			F	8.7	2.	8.4	As certified.
0615	The Meader-Atlas Co., New York, N. Y. "Monogram Feed"	Brooklyn	G	14.	2.	12.	Pure alfalfa meal, oil meal, dried brewers' grains, sugar cane molasses.
			F	13.2	2.6	9.3	Alfalfa meal, brewers' dried grains, molasses.
7573	Metropolitan Mills, New York, N. Y. "Alpha Grain Horse Feed"	Yonkers	G	9.	2.	15.	Cracked corn, whole oats, alfalfa meal and pure sugar cane molasses.
			F	8.7	3.8	10.5	As certified.
0613	Metropolitan Mills, New York, N. Y. "Arrowhead Horse Feed"	Brooklyn	G	10.	2.	15.	Pure alfalfa meal, cracked corn, whole oats, sugar cane molasses.
			F	12.2	3.	7.3	As certified.
7555	The Molassine Co., Boston, Mass. "Molassine Sphagnum Meal"	White Plains	G	7.	0.5	7.	Molasses and cooked sphagnum.
			F	7.5	0.8	4.4	Sphagnum moss, molasses.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
8416	A. Nowak & Son, Buffalo, N. Y. "Cream-O-Lene Dairy Ration"	Newark	G* 20.	4.	9.	Cottonseed meal, corn gluten feed, linseed oil meal, wheat middlings, corn distillers' dried grains, corn feed meal, clipped oat by-products, malt sprouts, brewers' dried grains, molasses, salt three-fourths of one per ct., ground or bolted screenings.
			F* 20.4	4.5	6.5	Cottonseed meal, corn gluten feed, linseed meal, wheat middlings, distillers' dried grains, corn feed meal, clipped oat by-product containing oat hulls, malt sprouts, molasses, salt.
8733	A. Nowak & Son, Buffalo, N. Y. "Butterine Dairy Feed"	Buffalo	G 17.5	4.	12.	Cottonseed meal, malt sprouts, dried brewers' grains, clipped oat by-product, ground and bolted grain screenings, molasses, three-fourths of one per ct. salt.
			F 19.7	4.1	8.4	As certified.
8744	A. Nowak & Son, Buffalo, N. Y. "Pure-Mo-Lene Horse Feed"	Silver Creek	G 9.	2.	12.	Cracked corn, crushed oats, whole oats, ground alfalfa, molasses, salt three-fourths of one per ct.
			F 9.	2.8	10.2	As certified.
8433	A. Nowak & Son, Buffalo, N. Y. "Pure Vim-O-Lene Horse Feed"	Corning	G 8.	2.	9.	Crushed oats, cracked corn, corn feed meal, wheat bran, molasses, salt three-fourths of one per ct.
			F 10.0	2.3	4.4	As certified.

7780	A. Nowak & Son, Buffalo, N. Y. "Union Dairy Feed"	Little Falls	G	12.	6.	15.	Ground wheat screenings, wheat bran, linseed oil meal, molasses, three-fourths of one per ct. salt, clipped oat by-product.
			F	10.3	2.8	13.5	Ground screenings from wheat, oats and flaxseed, molasses and salt.
7589	Omaha Alfalfa Milling Co., Omaha, Neb. "A1-Corn-O Horse Feed"	Yonkers	G	10.	2.	12.	Corn, oats, alfalfa meal and molasses.
			F	8.5	1.6	11.7	Cracked corn, crushed oats, alfalfa meal, molasses.
7596	Omaha Alfalfa Milling Co., Omaha, Neb. "Alfalfa Syr Feed"	Mount Kisco	G	11.	1.	25.	Alfalfa meal and syrup.
			F	7.4	0.7	11.9	Alfalfa meal, molasses.
7554	Omaha Alfalfa Milling Co., Omaha, Neb. "Green Meadow Dairy Feed"	White Plains	G	11.	1.	25.	Alfalfa meal and molasses.
			F	8.9	0.8	16.4	As certified.
8106	Omaha Alfalfa Milling Co., Omaha, Neb. "Peerless Horse Feed"	Poughkeepsie	G	10.	2.	12.	Corn, oats, alfalfa meal, molasses.
			F	9.3	2.	11.9	Cracked corn, crushed oats, alfalfa meal, molasses.
8308	The Park & Pollard Co., Boston, Mass. "The Park & Pollard Horse Feed"	Oswego	G	9.	2.5	12.	Alfalfa, corn, oats, molasses.
			F	9.4	2.2	10.2	Cracked corn, oats, alfalfa meal, molasses.
8268	T. R. Parker, Richfield Springs, N. Y. "Otsego Dairy Feed"	Richfield Springs	G	19.	6.	12.	Corn meal, linseed oil meal, cottonseed meal, corn gluten feed, distillers' grains, malt sprouts, dried brewers' grains, hominy feed, wheat bran, wheat middlings, buckwheat feed, molasses, ground wheat screenings, ground oat screenings, one-half of one per ct. salt.
			F	23.6	3.4	8.6	As certified.
0619	G. E. Patteson & Co., Memphis, Tenn. "Crown Horse Feed"	New York City	G	9.	2.	12.	Made from corn, alfalfa, oats, molasses.
			F	10.8	2.2	9.8	Cracked corn, whole oats, alfalfa meal, molasses.

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42

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
0620	G. E. Patteson & Co., Memphis, Tenn. "Patco Horse Feed"	New York City	G* 9. F* 11.2	2. 3.7	12. 9.3	Made from corn, oats, alfalfa and molasses. Cracked corn, whole oats, alfalfa meal, molasses.
8706	M. C. Peters Mill Co., Omaha, Neb. "June Pasture"	Buffalo	G 10. F 11.7	.5 1.2	26. 20.1	Pure alfalfa meal, light with molasses. Alfalfa meal, molasses.
0635	M. C. Peters Mill Co., Omaha, Neb. "Peters' Alfal-Fat Molasses Feed"	New York City	G 10. F 10.6	.5 1.3	26. 19.7	Alfalfa and molasses. Alfalfa meal, molasses.
7943	M. C. Peters Mill Co., Omaha, Neb. "Peters Arab Horse Feed"	Canisteo	G 9. F 9.2	2. 2.3	15. 7.8	Corn, oats, alfalfa and molasses. Cracked corn, whole oats, alfalfa meal, molasses.
0614	M. C. Peters Mill Co., Omaha, Neb. "Peters' High Score Alfalfa Molasses Feed"	Brooklyn	G 10. F 11.7	0.5 0.6	26. 12.4	Alfalfa meal, molasses.
8124	M. C. Peters Mill Co., Omaha, Neb. "Peters King Corn, Oats, Alfalfa, Corn & Molasses Feed"	Poughkeepsie	G 9. F 9.	1.5 1.6	18. 13.8	Corn, oats, alfalfa, molasses. Cracked corn, whole oats, alfalfa meal, molasses.
0616	M. C. Peters Mill Co., Omaha, Neb. "Peters' Rabbit Mule Feed"	Brooklyn	G 9. F 11.6	1.5 1.7	18. 11.6	Corn, oats, alfalfa and molasses. Cracked corn, whole oats, alfalfa meal, molasses.

8707	M. C. Peters Mill Co., Omaha, Neb. "Peters Re-Peter Horse Feed"	Buffalo	G	9.	1.5	18.	Corn, oats, alfalfa and molasses.
			F	10.5	1.8	10.8	Cracked corn, whole oats, alfalfa meal, molasses.
058	Purina Mills Branch, Ralston Purina Co., St Louis, Mo. "Purina O-Molene Horse Feed"	Batavia	G	10.5	4.	8.	Made from oats, cracked corn, wheat bran, molasses and one per ct. salt.
			F	8.5	3.4	4.9	Cracked corn, crushed oats, wheat bran, molasses, salt.
8219	The Quaker Oats Co., Chicago, Ill. "Blue Ribbon Dairy Feed"	Boonville	G	25.	3.5	12.	Made from hominy feed, malt sprouts, wheat bran with ground screenings not exceeding mill run, cottonseed meal, molasses, linseed meal, oat-meal mill by-product, oat middlings, oat hulls, oat shorts.
			F	24.2	3.9	9.4	As certified.
8114	The Quaker Oats Co., Chicago, Ill. "Green Cross Horse Mixed Feed with Molasses"	Poughkeepsie	G	10.	2.5	12.	Alfalfa meal, ground corn, crushed oats, molasses, cottonseed meal, oat meal mill by-product, oat middlings, oat hulls, oat shorts.
			F	9.6	2.7	11.2	As certified.
055	The Quaker Oats Co., Chicago, Ill. "Horse Power Brand Feed"	Bliss	G	10.	2.8	11.	Ground corn, crushed oats, new process linseed oil meal, molasses, oat meal mill by-product, oat hulls, oat shorts, oat middlings.
			F	9.7	2.3	9.4	As certified.
8158	The Quaker Oats Co., Chicago, Ill. "Quaker Dairy Feed with Molasses"	Pleasant Valley	G	16.	4.	14.5	Molasses, malt sprouts, cottonseed meal, ground grain screenings, clipped oat by-product, new process, linseed oil meal.
			F	15.4	3.6	11.4	As certified.
8137	Ralston Purina Co., St. Louis, Mo. "Good Luck Feed with Molasses"	Poughkeepsie	G	9.	1.5	12.	Cracked corn, whole oats, ground alfalfa, molasses and 1 per ct. salt.
			F	8.5	2.4	11.2	As certified.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
6369	Ralston Purina Co., Purina Mills Branch, St. Louis, Mo. "Protena Dairy Feed"	Batavia	G* 16.5	3.5	12.	Cottonseed meal, brewers' dried grains, clipped oat by-product, ground wheat screenings, molasses, one per ct. salt.
			F* 19.6	4.8	9.7	Cottonseed meal, brewers' dried grains, clipped oat by-product, ground grain screenings, molasses, salt.
8802	Ralston Purina Co., Purina Mills Branch, St. Louis, Mo. "Purina Cow Chow Feed"	Fort Edward	G 24.	5.	12.	Cottonseed meal, hominy feed, brewers' dried grains, molasses, ground alfalfa and one per ct. of salt.
			F 24.2	4.7	13.3	As certified.
7133	Ralston Purina Co., Purina Mills Branch, St. Louis, Mo. "Purina Dairy Feed"	Stamford	G 20.	3.8	15.	Made from cottonseed meal, brewers' dried grains, corn feed meal, ground alfalfa, molasses and one per ct. of salt.
			F 21.6	3.5	15.7	As certified.
6370	Ralston Purina Co., Purina Mills Branch, St. Louis, Mo. "Purina Feed with Molasses"	Batavia	G 9.3	1.7	11.7	Cracked corn, whole oats, ground alfalfa, molasses and one per ct. salt.
			F 8.7	2.2	8.4	As certified.
05	Ralston Purina Co., St. Louis, Mo. "Purina Sweet Feed"	Stamford	G 9.	1.	18.	Ground alfalfa, molasses and one per ct. salt.
			F 9.3	1.4	17.5	Alfalfa meal, molasses, salt.
7338	Republic Milling Co., East St. Louis, Ill. "Pennant Mixing Feed"	Franklinville	G 13.5	2.5	15.	Ground barley and flax screenings, oat clips, malt sprouts, salt and molasses.
			F 12.4	5.2	14.1	Oat clippings, ground grain and flax screenings, cottonseed meal, molasses, salt; malt sprouts present only in traces.

0381	Republic Milling Co., East St. Louis, Ill. "Republic Dairy Feed"	Montgomery	G 16.5	3.	12.	C. S. meal, malt sprouts, alfalfa, ground screenings (from oats, wheat, barley), cane molasses, salt.
			F 16.1	3.6	14.4	Cottonseed meal, malt sprouts, alfalfa, ground screenings from oats, wheat, barley and flaxseed, molasses, salt.
0170	Republic Milling Co., East St. Louis, Ill. "Republic Horse Feed"	Albany	G 9.	2.	12.	Corn, oats, alfalfa, cane molasses, salt.
			F 8.9	1.9	12.7	Cracked corn, whole oats, alfalfa meal, molasses, salt.
0618	John M. Reuter & Co., Elizabeth, N. J. "Reuter's Special Horse and Mule Feed"	New York City	G 8.	1.5	17.	Corn, oats, alfalfa and molasses.
			F 11.3	1.4	13.1	Cracked corn, crushed oats, alfalfa meal, molasses.
8035	Robinson & Erler, Inc., Riverhead, N. Y. "Erler's Horse and Cow Feed"	Valley Stream	G 10.	3.	4.	Corn meal, wheat bran, linseed meal, salt, molasses, and nothing else.
			F 10.5	3.0	3.4	Corn meal, wheat bran, molasses, salt, linseed meal present in very small amount.
8050	Robinson & Erler, Inc., Riverhead, N. Y. "Erler's Excelsior Feed with Alfalfa"	Riverhead	G 10.5	4.	16.	Alfalfa, whole oats, cracked corn, linseed meal, salt and molasses, crushed oats.
			F 10.	3.	10.3	As certified.
0607	Chas. Schaefer & Son, Brooklyn, N. Y. "American Alfalfa Molasses Feed"	Brooklyn	G 9.	1.	25.	Alfalfa, molasses.
			F 10.1	0.7	14.0	Alfalfa meal, molasses.
0606	Chas. Schaefer & Son, Brooklyn, N. Y. "American Standard Horse Feed"	Brooklyn	G 9.	2.5	14.	Alfalfa meal, corn, oats and sugar cane molasses.
			F 9.1	2.	10.9	Cracked corn, whole oats, alfalfa meal, molasses, salt.
0605	Chas. Schaefer & Son, Brooklyn, N. Y. "C. S. and S. Horse Feed"	Brooklyn	G 9.	2.5	14.	Alfalfa meal, corn, oats and sugar cane molasses.
			F 10.4	2.3	11.5	Cracked corn, whole oats, alfalfa meal, molasses, salt.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	COMPOUNDED FEEDS, MOLASSES (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
7561	J. C. Smith & Wallace Co., Newark, N. J. "Prize Horse Feed"	Port Chester	G* 10.	2.	12.	Corn, alfalfa meal, oats, molasses and one per ct. salt.
			F* 10.9	2.1	9.4	Cracked corn, crushed oats, alfalfa meal, molasses, salt.
7345	The Sugarine Co., Peoria, Ill. "Sugarine Dairy Feed"	Olean	G 16.5	3.5	12.	Molasses, cottonseed meal, corn gluten feed, and ground bolted grain screenings, clipped oat by-product, linseed meal and salt.
			F 16.3	6.	12.	Clipped oat by-product, ground grain and flax screenings, cottonseed meal, linseed meal, molasses, salt.
8568	Tioga Mill & Elevator Co., Waverly, N. Y. "Derby Horse Feed"	Waverly	G 9.75	1.85	17.	Corn, oats, alfalfa, cane molasses.
			F 10.6	2.6	6.1	Cracked corn, whole oats, alfalfa meal, molasses.
8567	Tioga Mill & Elevator Co., Waverly, N. Y. "Tioga Dairy Feed"	Waverly	G 16.75	4.	12.	Corn gluten feed, ground grain screenings, oat hulls, oat middlings, cottonseed meal, alfalfa meal, cane molasses, one-half of one per ct. salt.
			F 18.5	4.4	8.9	As certified.
8156	United States Sugar Feed Co., Milwaukee, Wis. "U. S. Sugared Feed"	Pleasant Valley	G 15.	3.	12.	Cottonseed meal, mixed broken grain screenings (from wheat, corn, oats, barley and oat clips), cane molasses and salt.
			F 18.6	3.2	12.7	Cottonseed meal, oat clippings, ground grain screenings, molasses, salt, malt sprouts present in small amount.

8073	Warner & Stellwagen, Brooklyn, N. Y. "Sterling Horse Feed"	Brooklyn	G 10.	4.	6.	Crushed oats, cracked corn, rice bran, molasses.
			F 9.6	6.3	5.1	As certified.
7041	The Wash-Co. Alfalfa M. F. & Mlg. Co., Ft. Calhoun, Neb. "Butler Special Horse Feed"	Ithaca	G 10.	2.	15.	Corn, oats, and alfalfa flavored with syrup.
			F 10.6	1.6	7.2	Cracked corn, whole oats, alfalfa meal, molasses.
8163	Weldon F. Weston & Co., Beacon, N. Y. "Weston's Dairy Feed with Alfalfa and Molasses"	Beacon	G 19.	3.5	12.	Cottonseed meal, dry brewers' grains, corn gluten, corn meal, beet pulp, cane molasses, alfalfa meal, salt.
			F 19.7	3.9	10.6	As certified.
8162	Weldon F. Weston & Co., Beacon, N. Y. "Weston's Horse Feed with Alfalfa and Molasses"	Beacon	G 12.	2.	13.	Alfalfa meal, crushed oats, dried brewers' grains, cracked corn, molasses, oil meal, salt.
			F 11.8	2.8	11.3	Alfalfa meal, crushed oats, brewers' dried grains, cracked corn, linseed meal, molasses, salt.
7088	Western Grain Product Co., Hammond, Ind. "Hammond Dairy Feed"	Sidney Center	G 16.5	3.5	11.	Cottonseed meal, corn distillers' grains, malt sprouts, ground clipped oat by-product, ground grain screenings, molasses, and salt.
			F 15.7	4.3	13.8	Clipped oat by-product, ground grain and flax screenings, cottonseed meal, a small amount of malt sprouts, molasses, salt.
088	Wollenberg Bros., Buffalo, N. Y. "W. B. Horse Feed"	Buffalo	G 10.	2.5	12.	Oats, corn, alfalfa and molasses.
			F 11.6	2.8	9.8	Cracked corn, crushed oats, alfalfa meal, molasses.
7910	Xtravim Molasses Feed Co., Boston, Mass. "Xtra-Vim Feed"	Warsaw	G 4.61	0.8	4.5	Pure cane sugar molasses mixed with small percentage of sphagnum moss and dehydrated.
			F 4.4	0.6	4.4	Sphagnum moss, molasses.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS COMPOUNDED:		*Per ct.*	*Per ct.*	*Per ct.*	
7336	Acme Milling Co., Olean, N. Y. "Acme Dry Mash"	Olean	G* 13.	3.	4.	Corn meal, gluten meal "made from whole corn," O. P. oil meal, wheat bran and middlings, hen-e-ta grits, salt and beef scraps, alfalfa meal.
			F* 16.8	4.3	4.8	As certified.
8061	J. & T. Adikes, Jamaica, N. Y. "Real Egg Mash"	Jamaica	G 10.	2.4	.14	Alfalfa meal, middlings, bran, corn feeding meal, linseed meal, meat scraps, ground screenings.
			F 13.4	3.7	6.1	Wheat bran, wheat middlings and ground screenings, alfalfa meal, corn feed meal, linseed meal, meat scrap.
7968	Allen Milling Co., Niagara Falls, N. Y. "Allen's Mash for Layers"	Spencerport	G 20.	3.	9.	Wheat bran, wheat middlings, alfalfa meal, corn meal, ground oats, linseed meal, ground charcoal, malt sprouts, heneta bone, bone meal, cottonseed meal, corn gluten feed, meat scraps, blood meal, nutro salts, ground shredded wheat and salt.
			F 18.4	4.1	7.	Wheat bran, wheat middlings, alfalfa meal, corn meal, ground oats, linseed meal, cottonseed meal, corn gluten feed, meat scrap, blood meal, shredded wheat, heneta grit, charcoal, bone meal, salt, epsom salt.

8741	Allen Milling Co., Niagara Falls, N. Y. "Allen's Nutro Chick Mash"	Niagara Falls	G 18.	3.	8.	Nutro salts, wheat bran, wheat middlings, alfalfa meal, corn meal, ground oats, linseed meal, ground charcoal, heneta grit, bone and meat meal, cottonseed meal, corn gluten feed, blood meal, ground shredded wheat and salt.
			F 17.8	3.7	6.9	Wheat bran, wheat middlings, alfalfa meal, corn meal, ground oats, linseed meal, cottonseed meal, corn gluten feed, blood meal, shredded wheat, heneta grit, charcoal, meat meal, bone meal, salt, epsom salt.
0647	American Hominy Co., Indianapolis, Ind. "Homco Dry Mash"	New York City	G 14.	4.	7.	Homco, homcoline, wheat middlings, bran, linseed oil meal, heneta.
			F 12.9	5.2	4.1	Wheat bran, wheat middlings, hominy feed, corn germ meal, linseed oil meal, heneta grit.
0648	American Hominy Co., Indianapolis, Ind. "Homco Scratch Feed"	New York City	G 10.	2.5	6.	Cracked corn, wheat, homcoline (corn germ meal), kaffir corn, barley and sunflower seed.
			F 11.1	3.2	1.8	Cracked corn, wheat, kaffir corn, barley, sunflower seed, corn germ meal.
0646	American Hominy Co., Indianapolis, Ind. "Homco Superior Scratch Feed"	New York City	G 10.5	2.5	5.	Cracked corn, whole wheat, barley, kaffir corn, homcoline (corn germ meal), sunflower seed.
			F 11.7	3.1	2.	Cracked corn, corn germ meal, wheat, barley, kaffir corn, sunflower seed.
7585	American Milling Co., Peoria, Ill. "Cluck Cluck Scratch Feed"	Philmont	G 10.	2.5	5.	Corn, wheat, barley, kaffir corn, sunflower seed and buckwheat.
			F 10.5	3.2	2.2	As certified.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS, COMPOUNDED (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
8522	American Milling Co., Peoria, Ill. "Sucrene Poultry Mash"	Waverly	G* 18.	4.5	9.	Alfalfa meal, linseed oil meal, corn meal, wheat bran, corn gluten feed, meat scraps, ground and bolted grain screenings.
			F* 19.4	4.2	7.	As certified.
8197	American Milling Co., Peoria, Ill. "Sucrene Scratch Feed"	Dover Plains	G 10.	2.5	5.	Corn, wheat, kaffir corn, linseed oil cake, sunflower seed, buckwheat and barley.
			F 11.6	3.	2.8	As certified.
8702	W. J. Beier, Jr., Buffalo, N. Y. "Frontier Poultry Mash"	Buffalo	G 15.	4.	6.	Ground corn, wheat bran and middlings, hominy feed, corn gluten feed, oat middlings and rolled oats.
			F 16.1	5.8	5.1	As certified.
7941	Blatchford's Calf Meal Factory, Waukegan, Ill. "Blatchford's Fill the Basket Egg Mash"	Hornell	G 19.	4.	10.	Locust bean meal, unpressed flaxseed, rice polish, wheat flour, barley meal, ground beans and peas, old process oil meal, cocoa shell meal, cocoanut meal, recleaned cottonseed meal, foenugreek, dried milk, anise, salt, also alfalfa, bone, corn and oat meals, wheat bran, wheat middlings beef scraps, fish, capsicum, powdered limestone.
			F 18.7	4.4	8.3	As certified.
8056	S. W. Bowne Co., Brooklyn, N. Y. "Bowne's Dry Mash for Poultry"	Northport	G 19.	4.	7.	Wheat midds, bran, corn meal, linseed oil meal, meat scrap, alfalfa meal.
			F 19.9	6.1	4.7	As certified.

8023	Brooklyn Elevator & Milling Co., Brooklyn, N. Y. "Bemco Poultry Mash"	Mineola	G 12.	3.	5.	Corn meal, corn gluten feed, wheat bran, old process oil meal, wheat middlings, heneta grit.
			F 11.7	3.2	3.7	Corn meal, corn gluten feed, wheat bran, wheat middlings, linseed meal, heneta grit.
6641	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Laying Mash"	Hudson Falls	G 20.	5.	6.	Ground corn, oats, wheat and kaffir corn, wheat bran, wheat middlings, linseed meal, alfalfa meal, oat middlings, meat and bone scrap, one-half of one per ct. salt.
			F 20.8	7.4	6.8	As certified.
0376	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Laying Mash"	Middletown	G 20.	5.	6.	Ground corn, oats, wheat and kaffir corn, wheat bran, wheat middlings, linseed meal, alfalfa meal, oat middlings, meat and bone scrap, one-half of one per ct. salt.
			F 20.8	7.3	5.8	As certified.
8112	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Poultry Mash"	Poughkeepsie	G 15.	4.	6.	Ground corn, wheat bran and middlings, hominy feed, corn gluten feed, oat middlings and rolled oats.
			F 15.9	4.9	4.9	As certified.
7559	Buffalo Cereal Co., Buffalo, N. Y. "Iroquois Poultry Mash"	Mount Vernon	G 14.	4.	12.	Ground corn, wheat bran and middlings, corn gluten feed, alfalfa meal.
			F 16.2	5.1	7.9	Ground corn, wheat bran, wheat middlings, corn gluten feed, alfalfa meal, cottonseed meal present in small amount.
8065	Certified Farm Co., New York, N. Y. "Brand No. 2 Certified Laying Mash"	New York	G 18.	4.5	9.	Wheat bran, wheat middlings, ground oats, corn meal, gluten meal, alfalfa, meat scrap.
			F 15.6	3.6	6.1	Wheat bran, wheat middlings, ground oats, corn meal, corn gluten meal, alfalfa meal, meat scrap.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	POULTRY FOODS, COMPOUNDED (*con.*):					
7976	Chesbro Milling Co., Salamanca, N. Y. "Trojan Poultry Mash"	Rochester	G* 17.	4.	10.	Beef scraps, oil meal, alfalfa meal, cottonseed meal, bran, corn meal, chick cracked corn, wheat, ground oats, barley, fish meal.
			F* 20.4	4.8	8.8	Meat scrap, linseed meal, alfalfa meal, cottonseed meal, wheat bran, corn meal, cracked corn, ground oats, wheat, barley, fish scrap.
8482	Shelly G. Crump, Pittsford, N. Y. "Cornell Laying Mash"	Pittsford	G ——	——	——	Corn meal, wheat middlings, wheat bran, alfalfa meal, oil meal, a trace of salt.
			F 18.	8.5	5.	Corn meal, wheat bran, wheat middlings, alfalfa meal, linseed oil meal, meat and bone scrap, salt.
8083	A. Cyphers Co., Newark, N. J. "Cypho Chick Food A Grade"	New York	G 10.	2.	3.	Cracked corn, cracked kaffir corn, oat groats, cracked wheat, broken rice, millet seed, cracked green peas.
			F 12.	3.6	1.9	As certified.
8084	A. Cyphers Co., Newark, N. J. "Cypho Morning Mash A Grade"	New York	G 15.	3.	12.	Corn meal, ground kaffir corn, wheat middlings with mill run of screenings, alfalfa meal, rolled oats, cottonseed meal, linseed meal, corn gluten meal, buckwheat middlings and buckwheat hulls, ground charcoal, meat and bone meal.
			F 19.6	4.5	9.6	Corn meal, ground kaffir corn, wheat middlings, with ground screenings, alfalfa meal, rolled oats, cottonseed meal, linseed meal, corn gluten feed, buckwheat middlings, buckwheat hulls, ground charcoal, meat and bone meal.

7321	Cyphers Incubator Co., Buffalo, N. Y. " Cyphers' Laying Mash "	Buffalo	G	15.	3.	6.	Kaffir meal, wheat bran, red dog, wheat middlings, corn meal, alfalfa meal, blood meal.
			F	13.2	3.5	3.1	Kaffir corn meal, wheat bran, wheat middlings, red dog flour, corn meal, alfalfa meal, blood meal.
7320	Cyphers Incubator Co., Buffalo, N. Y. " Cyphers' Fattening Mash "	Buffalo	G	11.	3.	5.	Kaffir meal, wheat bran red dog, wheat middlings, corn meal, alfalfa meal.
			F	12.3	3.4	2.5	Ground kaffir corn, wheat bran, wheat middlings, red dog flour, corn meal, alfalfa meal present in very small amount.
8067	Cyphers Incubator Co., Buffalo, N. Y. " Fertile Egg Mash "	New York	G	10.	3.	12.	Wheat bran, wheat middlings, ground oats, corn meal, alfalfa meal.
			F	11.9	4.	4.2	Wheat bran, wheat middlings, ground oats, corn meal, alfalfa meal, approximately 2.1 per ct. kaffir corn present.
8066	Cyphers Incubator Co., Buffalo, N. Y. " Growing Mash "	New York	G	10.	3.	10.	Ground oats, corn meal, wheat middlings, alfalfa meal, bone and meat meal.
			F	13.4	3.6	2.9	Wheat bran, wheat middlings, corn meal, ground oats, meat and bone meal, approximately 2.5 per ct. ground kaffir corn present. Alfalfa meal present in very small amounts.
8726	The Albert Dickinson Co., Chicago, Ill. " Dickinson's Globe Egg Mash "	Jamestown	G	16.	3.	10.	Made from alfalfa meal, bran, middlings, wheat meal, corn feed meal, ground corn bran, linseed oil cake, meat scrap, one-half of one per ct. salt.
			F	16.4	4.2	6.5	Alfalfa meal, wheat bran, wheat middlings, wheat meal, corn feed meal, ground corn bran, linseed oil cake, meat scrap, salt.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS, COMPOUNDED (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
8518	The Albert Dickinson Co., Chicago, Ill. " Dickinson's Globe Scratch Feed "	New Berlin	G* 10.	2.5	5.	Corn, wheat, barley, oats, kaffir corn, buckwheat, sunflower and linseed oil cake.
			F* 10.1	2.8	2.5	As certified.
7919	The Albert Dickinson Co., Chicago, Ill. " Queen Poultry Mash "	Perry	G 11.	2.5	10.	Alfalfa meal, corn feed meal, wheat meal, ground corn bran, wheat bran, meat scraps, linseed oil cake, salt one-half of one per ct.
			F 12.	4.7	6.7	As certified.
8721	Edwards & Loomis Co., Chicago, Ill. " Red Comb Mash Feed (with shell and charcoal)"	Jamestown	G 15.	4.	8.	Oat meal, oil meal, corn feed meal, meat scraps, wheat bran, wheat middlings, alfalfa meal, and not over 5 per ct. shell, 1 per ct. charcoal.
			F 17.8	4.3	8.4	Oat meal, linseed meal, corn meal, meat scrap, wheat bran, wheat middlings, alfalfa meal, ground oyster shells, charcoal; approximately 1 per ct. of kaffir corn present.
7090	Elmore Milling Co., Oneonta, N. Y. " Elmore Egg Mash "	Franklin Depot	G 18.	4.	8.	Corn meal, rolled oats, ground barley, wheat flour midds, hominy feed, wheat bran, meat and bone meal, corn gluten feed, alfalfa meal, O. P. oil meal, salt.
			F 18.9	5.1	5.5	Corn meal, rolled oats, ground barley, wheat bran, wheat middlings, hominy feed, meat and bone meal, corn gluten feed, alfalfa meal. linseed meal, salt.

8605	Empire Stock & Poultry Food Co., Auburn, N. Y. "Empire Poultry Regulator"	Auburn	G	24.7	6.1	15.25	Oil meal, sulphur, gentiana lutea, sem. foenugreek, sem. anise, pulv. capsicum, pulv. carbo lig., shell.
			F	21.	5.9	15.9	Linseed oil meal, sulphur, gentian, fenugreek, anise, capsicum, charcoal, oyster shell, salt.
8275	Empire Grain & Elevator Co., Binghamton, N. Y. "Neverfail Egg Producer"	Bridgewater	G	8.75	3.75	4.25	Wheat, corn, barley, oats, kaffir corn, buckwheat, milo maize.
			F	9.7	3.5	2.4	As certified.
0564	The Gates Elevator Co., Cleveland, O. "Gates Quality Poultry Mash"	Westfield	G	19.5	5.	8.	Alfalfa meal, oil meal, beef scrap, gluten, bran, white middlings, salt, corn meal.
			F	20.1	5.2	7.3	Alfalfa meal, linseed oil meal, beef scrap, corn gluten feed, wheat bran, wheat middlings, corn meal, salt.
0611	William Germuth, Richmond Hill, L. I. "Dunton Poultry Mash"	Richmond Hill	G	17.3	4.3	8.8	Alfalfa meal, wheat middlings, wheat bran, corn meal, meat scrap.
			F	17.4	5.5	9.5	As certified.
0184	G. W. Gerow, Vails Gate, N. Y. "Gerow's Poultry Mash"	Vails Gate	G	10.	3.	8.	Hominy feed, corn meal, corn gluten feed, wheat bran, wheat middlings, ground oats, alfalfa meal, dried beet pulp, meat and bone scrap, charcoal.
			F	13.9	4.8	7.7	As certified.
7581	Globe Elevator Co., Buffalo, N. Y. "Blue Ribbon Growing Mash"	Peekskill	G	15.	4.	7.	Made from wheat, corn gluten meal, corn meal, oat meal.
			F	15.9	4.8	5.1	Wheat bran, corn gluten meal, corn meal, oat meal.
7036	Globe Elevator Co., Buffalo, N. Y. "Blue Ribbon Laying Mash"	Groton	G	20.	3.	10.	Wheat bran, wheat middlings, wheat flour, ground oats, corn meal, corn gluten meal, pea meal, ground alfalfa, linseed oil meal, meat meal, fish scraps, ground bone.
			F	19.6	5.2	7.1	As certified.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS, COMPOUNDED (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
8238	Globe Elevator Co., Buffalo, N. Y. "Blue Ribbon Scratch Feed"	Whitesboro	G* 12.	4.	4.	Cracked corn, wheat, barley, kaffir corn, oats, buckwheat, sunflower seed, green split peas.
			F* 11.8	2.9	3.1	As certified.
0374	H. W. Gordinier & Sons Co., Troy, N. Y. "Oak Brand Scratching Grains (no grit)"	Troy	G ——	——	——	
			F 10.5	3.5	2.4	Wheat, kaffir corn, milo maize, barley, buckwheat, sunflower seed, cracked corn, linseed oil cake.
074	Harvey Seed Co., Buffalo, N. Y. "Electric Poultry Food"	Buffalo	G 12.	3.	——	Corn meal, wheat middlings, corn starch by-product with corn bran, cottonseed meal, wheat bran, linseed meal.
			F 15.4	4.4	4.1	Corn meal, wheat bran, wheat middlings, corn gluten feed, cottonseed meal, linseed meal.
8401	The Hen-ty Mfg. Co., Auburn, N. Y. "The Hen-ty Laying Mash"	Auburn	G 16.	5.	6.	Linseed meal, cottonseed meal, corn gluten feed, corn meal, wheat bran, wheat middlings, ground oats, hominy feed, fish scraps, beef scraps, bone meal, meat meal, oyster shell meal, alfalfa meal, charcoal. The absence of ground wheat screenings, mill run, is not guaranteed.
			F 18.3	5.	5.1	Linseed meal, cottonseed meal, corn gluten feed, corn meal, wheat bran and wheat middlings containing traces of ground screenings, ground oats, hominy feed, fish scrap, meat scrap, meat meal, bone meal, oyster shell meal, alfalfa meal, charcoal.

7390	A. H. Herrick & Son Watertown, N. Y. " Herrick's Quality Soft Feed "	Watertown	G 22.31	6.69	6.77	Linseed oil meal, corn meal, wheat bran, wheat middlings, alfalfa meal, beef scrap.
			F 25.4	5.6	4.3	Wheat bran, wheat middlings, corn meal, alfalfa meal, linseed meal, meat and bone scrap.
7318	The H-O Mills, Buffalo, N. Y. " The H-O Co's Chick Feed "	Buffalo	G 12.	3.	9.	Cracked corn, cut oat meal, cracked wheat, cracked kaffir corn, cracked peas, millet.
			F 13.4	4.8	2.4	Cracked corn, cut oat meal, cracked wheat, cracked kaffir corn, cracked peas, millet. Approximately 3.8 per ct. weed seed present.
8042	The H-O Co., Buffalo, N. Y. " The H-O Co's Poultry Feed "	Valley Stream	G 17.	4.5	9.	Ground corn, corn gluten feed, wheat midds, oat midds, wheat bran, hominy feed, rolled oats, ground grain screenings, molasses, ground peas.
			F 17.6	4.1	7.1	As certified.
8068	The H-O Co., Buffalo, N. Y. " The H-O Co's Steam Cooked Chick Feed "	Brooklyn	G 12.	3.	9.	Cracked corn, cut oat meal, cracked wheat, cracked kaffir corn, cracked peas, millet.
			F 12.1	3.1	1.5	Cracked corn, cut oat meal, cracked wheat, cracked kaffir corn, cracked peas, millet. Approximately 2.7 per ct. weed seeds present.
7934	Stephen Hollands & Sons, Hornell, N. Y. " Hollands Dry Mash "	Hornell	G 18.	4.5	11.	Ground oats, corn meal, ground bone, dried milk, ground barley, meat scraps, ground charcoal, linseed meal, alfalfa meal, wheat middlings cotton-seed meal, corn gluten feed, wheat bran, small amount of salt.
			F 21.4	4.5	7.5	As certified.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS, COMPOUNDED (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
8195	International Sugar Feed Co., Minneapolis, Minn. "International Poultry Feed (Scratch)"	Towners	G* 10.	3.5	5.	Wheat, oats, barley, corn, kaffir corn or milo maize, buckwheat, sunflower seed.
			F* 11.8	3.5	3.	Wheat, oats, barley, cracked corn, milo maize, buckwheat, sunflower seed.
7328	Jamestown Electric Mills, Jamestown, N. Y. "Purity Poultry Mash"	Little Valley	G 12.	3.	3.5	Corn meal, corn gluten feed, wheat middlings, wheat bran, linseed oil meal, pea meal, heneta grits.
			F 13.4	3.3	4.9	Wheat bran, wheat middlings, corn meal, corn gluten feed, linseed meal, pea meal, heneta grits.
8467	F. L. Jennings, Elmira, N. Y. "Reliable Poultry Mash"	Elmira	G 20.28	5.75	6.25	Wheat bran, wheat middlings, corn meal, alfalfa meal, linseed oil meal, beef and bone scrap, charcoal and oat flake.
			F 19.5	5.6	6.7	As certified.
7795	Chas. A. Krause, Milwaukee, Wis. "Blue Top Scratch Feed"	Poland	G 10.	2.5	5.	Wheat, cracked corn, kaffir corn, barley, oats and sunflower seeds.
			F 10.4	3.4	2.1	As certified.
8533	D. Maydole & Co., Norwich, N. Y. "Old Stone Grist Mill Celebrated Dry Mash"	Norwich	G 17.4	4.21	15.35	Corn meal, white middlings, oat feed, wheat bran, O. P. oil meal, hominy, Buffalo corn gluten, beef scrap, alfalfa meal, one-half of one per ct. salt.
			F 21.3	4.4	11.4	Corn meal, wheat bran, wheat middlings, oats, oat hulls, hominy feed, corn gluten feed, beef scrap, alfalfa meal, cottonseed meal, linseed meal, salt.

8521	Moses Bros., Eaton, N. Y. "Madison Poultry Mash"	Hamilton	G 15.	3.	10.	Alfalfa meal, wheat bran, corn meal, corn gluten feed, bone and meat meal, wheat midds, linseed oil meal, milk albumen, salt.
			F 21.1	4.2	8.3	Alfalfa meal, wheat bran, wheat middlings, corn meal, corn gluten feed, meat and bone meal, milk albumen, linseed meal, salt.
7970	Mystic Milling & Feed Co., Rochester, N. Y. "Mystic Laying Mash"	Rochester	G 23.	4.	8.	Wheat middlings, wheat bran, corn meal, corn gluten feed, oil meal, alfalfa meal, blood meal, bone meal, meat meal.
			F 22.2	4.4	5.8	Wheat bran, wheat middlings, corn meal, corn gluten feed, linseed meal, alfalfa meal, meat meal, blood meal, bone meal.
0195	A. Nowak & Son, Buffalo, N. Y. "Justice Growing Mash"	Troy	G 15.	5.	7.	Oat meal, corn gluten feed, linseed oil meal, corn feed meal, wheat bran, wheat middlings.
			F 16.	4.	5.2	As certified.
0196	A. Nowak & Son, Buffalo, N. Y. "Justice Laying Mash"	Troy	G 20.	3.	10.	Linseed oil meal, ground oats, wheat flour, wheat bran, wheat middlings, corn feed meal, corn gluten feed, alfalfa meal, ground bone, meat scrap.
			F 19.8	5.2	6.9	As certified.
7078	A. Nowak & Son, Buffalo, N. Y. "Lay-Egg-O Dry Mash"	Walton	G 12.	3.	4.	Composed of corn feed meal, corn gluten feed, wheat bran, wheat middlings and Heneta (phosphorus, lime, sodium and silica.)
			F 13.4	3.3	4.8	Corn feed meal, corn gluten feed, wheat bran, wheat middlings, heneta grit.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS, COMPOUNDED (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
0365	Nowak Milling Corporation, Buffalo, N. Y. "Marathon Scratch Feed"	Schenectady	G* 10.	3.	5.	Wheat, milo maize, cracked corn, buckwheat, barley, recleaned grain screenings.
			F* 10.3	3.	2.7	Wheat, milo maize, cracked corn, barley, grain screenings, buckwheat present in very small amounts.
0151	The O. K. Company, New York, N. Y. "Puritan Chick Food"	New York	G 12.5	7.1	6.	Corn, wheat, meat, bone, oyster shell, sulphur, anise seed, charcoal and fenugreek.
			F 13.4	6.2	4.9	Hominy feed, wheat middlings, meat, bone, ground oyster shells, sulphur, anise, fenugreek, powdered charcoal.
0186	Wm. Orr & Sons, Orr's Mills, N. Y. "Orr's Digestible Laying Mash"	Orr's Mills	G 12.	3.	10.	Wheat bran, corn meal, meat scrap, fish scrap, wheat middlings, ground oats, ground barley, dried beet pulp, alfalfa meal, alpha meal, salt, old process linseed oil meal, corn gluten feed.
			F 18.8	3.7	5.3	Wheat bran, wheat middlings, corn meal, ground oats and barley, meat scrap, fish scrap, dried beet pulp, alfalfa meal, linseed meal, alpha meal (nabisco dough, low grade flour), corn gluten feed, salt.

0185	Wm. Orr & Sons, Orr's Mills, N. Y. "Orr's Growing Chick Mash"	Orr's Mills	G 15.	3.	7.	Wheat bran, corn meal, wheat middlings, ground barley, Rock river oat meal, heneta bone meal, meat scrap, corn gluten meal, alpha meal (nabisco dough, low grade flour), rye middlings, milk albumen.
			F 15.8	3.9	2.6	Wheat bran, wheat middlings, rye middlings, corn meal, ground barley, oat meal, meat scrap, corn gluten meal, milk albumen, alpha meal (nabisco dough, low grade flour), heneta grit.
8160	The Park & Pollard Co., Boston, Mass. "Gritless Chick Feed"	Beacon	G 11.	3.5	5.	Cracked corn, wheat, kaffir corn, milo, whole millet seed, oats and shredded fish.
			F 13.8	2.8	2.8	Cracked corn, wheat, kaffir corn, milo maize, whole millet seed, oat groats, shredded fish.
8034	The Park & Pollard Co., Boston, Mass. "Growing Feed"	Valley Stream	G 10.	3.5	8.	Ground corn, wheat, barley, oats, meat, bone, alfalfa, kaffir corn, wheat bran, wheat middlings, buckwheat, beet pulp, calcium carbonate and salt.
			F 16.2	4.1	4.2	As certified.
8118	The Park & Pollard Co., Boston, Mass. "Lay or Bust Dry Mash"	Poughkeepsie	G 18.	3.5	12.	Ground:— Wheat bran, wheat middlings, corn, wheat, oats, barley, kaffir corn, buckwheat, alfalfa, fish meat, bone, beet pulp, calcium carbonate and salt.
			F 18.4	2.9	8.2	Wheat bran, wheat middlings, ground corn, wheat, oats, barley, kaffir corn, buckwheat, alfalfa meal, fish scrap, meat and bone meal, dried beet pulp, calcium carbonate, salt.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS, COMPOUNDED (*con.*):		*Per ct.*	*Per ct.*	*Per c'.*	
8527	Phelps & Sibley Co., Cuba, N. Y. " Favorite Poultry Mash "	Candor	G* 17.	3.	9.	Linseed meal, beef scrap, alfalfa meal, gluten feed (corn product), ground oats, wheat middlings, corn meal, wheat bran, small quantity of charcoal, and salt.
			F* 20.1	5.	8.1	As certified.
7886	Pratt Food Co., Philadelphia, Pa. " Pratt's Baby Chick Food "	Syracuse	G 12.	4.5	3.	Hulled oats, corn meal, wheat middlings, epsom salts, bone meal, cooked wheat, pepper, gentian, millet, ginger rape, caraway, shell meal.
			F 13.1	4.1	2.4	As certified.
0162	Arthur E. Pratt Co., Inc., Albany, N. Y. " Arthur E. Pratt Co's Champion Chick Grains "	Albany	G 12.	3.	9.	Cracked corn, cut oat meal, cracked wheat, cracked kaffir corn, cracked peas, millet.
			F 12.6	2.2	2.3	Cracked corn, wheat, kaffir corn, split peas, whole millet seed, approximately 6.3 per ct. weed seeds present.
8837	Arthur E. Pratt Co., Albany, N. Y. " Arthur E. Pratt Co's Champion Egg Mash "	Mechanicville	G 13.	2.	4.	Corn meal, corn gluten feed, wheat middlings, wheat bran, old process linseed oil meal and heneta (composed of phosphorus, silica, lime and soda), high grade beef scrap.
			F 14.1	2.8	4.4	As certified.
0158	Arthur E. Pratt Co., Inc., Albany, N. Y. " Pratt's Champion Growing Mash "	Albany	G 12.	2.	4.	Corn meal, corn gluten feed, wheat middlings, wheat bran, old process linseed meal and hen-e-ta (composed of phosphorus, silica, lime and soda).
			F 12.7	3.6	4.8	As certified.

0202	Arthur E. Pratt Co., Inc., Albany, N. Y. "Arthur E. Pratt Co's Champion Growing Mash"	Kinderhook	G 12.	2.	4.	Corn meal, corn gluten feed, wheat middlings, wheat bran, old process linseed oil meal and hen-e-ta composed of phosphorus, silica, lime and soda.
			F 11.6	3.1	4.2	Wheat bran, wheat middlings, corn meal, corn gluten feed, linseed meal, heneta grit.
0386	Purity Oats Company, Davenport, Ia. "Tom Boy Scratch Feed" (No Grit)	Kingston	G 10.	3.	5.	Cracked corn, wheat, hulled oats, kaffir corn or milo maize, barley, recleaned wheat screenings, buckwheat and sunflower seed.
			F 11.5	3.1	2.3	Cracked corn, wheat, hulled oats, kaffir corn, milo maize, barley, wheat screenings, buckwheat, sunflower seed.
7579	The Quaker Oats Co., Chicago, Ill. "American Poultry Food"	Peekskill	G 12.	3.	9.	Hominy feed, cottonseed meal, ground barley, wheat mixed feed and rye shorts (with ground screenings not exceeding mill run).
			F 12.1	3.3	3.6	Hominy feed, corn feed meal, cottonseed meal, ground barley, wheat bran, wheat middlings, rye middlings containing a trace of ground screenings.
8037	The Quaker Oats Co., Chicago, Ill. "Quaker Chick Feed"	Valley Stream	G 10.	2.5	5.	Made from cracked wheat, cracked kaffir corn, cracked Indian corn, whole millet seed, oat meal, wild buckwheat with not to exceed one-half of one per ct. miscellaneous wild seeds occurring in above seeds and grains, charcoal and marble grit.
			F 11.2	3.5	2.8	Cracked wheat, cracked kaffir corn, cracked Indian corn, whole millet seed, hulled oats (including some hulls), charcoal, pigeon grass seed.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS, COMPOUNDED (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
7571	The Quaker Oats Co., Chicago, Ill. " Quaker Poultry Mash "	Yonkers	G* 17.5	4.	10.	Meat scraps, oat meal, wheat bran with ground screenings not exceeding mill run, alfalfa meal, yellow hominy feed, corn gluten feed, ground grain screenings.
			F* 17.4	6.6	7.3	As certified.
8742	Quaker Oats Co., Chicago, Ill. " Schumacher Little Chick Feed "	Ellicottville	G 10.	2.5	5.	Cracked wheat, cracked kaffir corn, cracked Indian corn, whole millet seed, oat meal, wild buckwheat with not to exceed one-half of one per ct. miscellaneous wild seed occurring in above seeds and grains, charcoal, marble grit.
			F 9.8	2.	2.3	As certified.
8153	The Quaker Oats Co., Chicago, Ill. " Schumacher Scratch Grains "	Clinton Corners	G 10.	2.5	5.	Whole wheat, whole kaffir corn, whole barley, cracked Indian corn, whole buckwheat, sunflower seeds.
			F 10.5	3.6	2.4	As certified.
7911	Ralston Purina Co., St. Louis, Mo. " Purina Chicken Chowder Feed with Charcoal "	Warsaw	G 17.	3.	9.	Wheat middlings, wheat bran, corn meal, salt, alfalfa meal, linseed meal, granulated meat, charcoal.
			F 20.1	5.1	4.8	As certified.
8237	Ralston Purina Co., St. Louis, Mo. " Purina Scratch Feed "	Whitesboro	G 11.	3.	4.	Wheat, corn, barley, kaffir, milo maize, sunflower.
			F 11.4	2.7	2.8	Cracked corn, whole wheat, barley, kaffir corn, milo maize and sunflower seed.

7588	J. A. Reynolds, Albany, N. Y. "Peerless Egg Mash"	Hudson	G	18.	4.	8.	Corn meal, rolled oats, ground barley, wheat flour midds, hominy feed, wheat bran, meat and bone meal, corn gluten feed, alfalfa meal, old process oil meal, salt.
			F	18.6	5.8	6.2	Corn meal, rolled oats, ground barley, wheat bran, wheat middlings, hominy feed, meat and bone meal, corn gluten feed, linseed meal, alfalfa meal, salt.
7558	Charles Rockwell & Co., Mt. Vernon, N. Y. "Charles Rockwell & Co. Dry Poultry Mash"	Mt. Vernon	G	18.	3.5	12.	Ground wheat bran, wheat middlings corn, wheat, oats, barley, kaffir corn, alfalfa, fish, meat and beet pulp.
			F	17.2	4.9	8.2	Wheat bran, wheat middlings, ground corn, wheat, oats, barley and kaffir corn, alfalfa meal, fish scrap, meat scrap, dried beet pulp, cottonseed meal, ground oyster shells, salt.
8512	J. De Ver Rogers & Son, Oxford, N. Y. "Rogers Dry Mash"	Oxford	G	14.	3.	4.	Corn meal, diamond corn gluten meal, wheat middlings, wheat bran, beef scrap and hen-e-ta (composed of phosphorus, silica, lime and soda).
			F	15.9	2.5	3.1	As certified.
8423	Sargeant & Sage, Elmira, N. Y. "Dry Mash"	Elmira	G	——	——	——	200 pounds bran, 100 pounds corn meal, 100 pounds wheat midds, 100 pounds beef scrap, 20 pounds alfalfa meal, 10 pounds charcoal.
			F	21.6	3.7	7.	Wheat bran, wheat middlings, corn meal, meat scrap, alfalfa meal, charcoal.
0604	Chas. Schaefer & Son, Brooklyn, N. Y. "American Standard Scratch Feed"	Brooklyn	G	11.	3.5	9.	Wheat, oats, kaffir corn, buckwheat, wheat screenings, cracked corn, milo maize, hulled oats, cracked peas.
			F	11.1	3.6	2.5	As certified.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS, COMPOUNDED (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
0601	Shaw & Truesdell Co., Brooklyn, N. Y. "Shaw & Truesdell Co's Poultry Mash"	Brooklyn	G* 18.	4.	8.	Corn meal, wheat bran, corn gluten meal, flour midds, linseed oil meal, beef scrap, alfalfa meal, one-half of one per ct. salt.
			F* 21.2	7.	5.7	As certified.
8421	Fred Smith, Elmira, N. Y. "Smith's Special Poultry Mash"	Elmira	G 15.	5.	7.	Wheat bran, wheat middlings, corn meal, oil meal, alfalfa meal, ground oats, gluten and beef scrap.
			F 18.3	2.8	6.1	Wheat bran, wheat middlings, corn meal, linseed meal, alfalfa meal, ground oats, corn gluten feed, beef scrap.
8511	Spratt's Patent (Am.) Ltd., Newark, N. J. "Spratt's Chick Meal"	Oxford	G 20.	2.	2.	Wheat flour and meat.
			F 22.3	3.1	1.4	Ground bread and meat. Approximately 1.4 per ct. mustard seed present.
0163	Spratt's Patent (Am.) Ltd., Newark, N. J. "Spratt's Chicgrain"	Albany	G 14.	3.	5.	Whole or ground:— Wheat flour, wheat, millet, canary, kaffir corn, green peas, hemp, buckwheat, pop corn, rice, meat, charcoal, bone, Mexican peas.
			F 15.1	3.	3.3	Cracked wheat, kaffir corn, peas, buckwheat, pop corn, rice, millet, canary seed, hemp seed, meat, bone, charcoal.

0355	L. L. Streeter & Sons, Fonda, N. Y. "Adirondack Egg Mash"	Fonda	G	19.5	5.	10.	Dried milk, corn feed meal, cocoanut meal, flaxseed meal, cottonseed meal, wheat flour middlings, wheat bran, corn gluten feed, ground peas, charcoal, ground white oats, alfalfa meal, meat and bone scrap, heneta grit and one-half of one per ct. salt.
			F	18.2	5.4	8.4	As certified.
8537	Syracuse Milling Co., Syracuse, N. Y. "Syragold Dry Mash"	Wampsville	G	12.	3.	5.	Wheat bran, wheat middlings, yellow corn meal, corn gluten feed, old process linseed meal, hen-e-ta.
			F	11.8	3.4	4.6	Wheat bran, wheat middlings, corn meal, corn gluten feed, linseed meal, heneta grit.
8564	W. I. Teed's Sons, Sayre, Pa. "Teed's Ready Mixed Laying Mash"	Waverly	G	18.	4.	8.	Corn gluten meal, wheat bran, wheat middlings, corn meal, beef scrap, linseed meal, ground oats, alfalfa meal, charcoal and salt.
			F	19.2	5.4	6.9	As certified.
8276	Tioga Mill & Elevator Co., Waverly, N. Y. "Derby Chick Feed"	West Winfield	G	10.	3.	3.5	Steel cut oat meal, cracked wheat, cracked corn, cracked kaffir corn, millet seed.
			F	10.2	2.8	1.6	As certified.
7854	Tioga Mill & Elevator Co., Waverly, N. Y. "Ti-O-Ga Dry Mash"	Homer	G	13.	3.75	5.25	Corn meal, corn germ, linseed meal, wheat flour, wheat bran, gluten feed, wheat middlings, kaffir corn meal, phospho silicate of lime and soda.
			F	14.2	3.4	4.2	Linseed meal, corn meal, corn germ, wheat bran, wheat middlings, wheat flour, corn gluten feed, kaffir corn meal, heneta grit.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	POULTRY FOODS, COMPOUNDED (*con.*):		*Per ct.*	*Per ct.*	*Per ct.*	
9011	L. R. Wallace, Middletown, N. Y. "Mapes Balanced Ration for Poultry"	Middletown	G* 12.	4.	8.	Animal meal, ground bone, corn meal, wheat middlings, wheat bran, corn gluten feed, ground oats and alfalfa meal.
			F* 13.3	2.6	5.7	As certified.
8404	H. J. Welch & Co., Geneva, N. Y. "Poultry Mash"	Geneva	G ——	——	——	Peters' Arab horse feed, oyster shell and milo maize.
			F 8.8	2.4	5.5	Cracked corn, whole oats, alfalfa meal, molasses, ground oyster shells, milo maize.
	CALF MEALS:					
8545	American Milling Co., Peoria, Ill. "Sucrene Calf Meal"	Binghamton	G 20	4.	3	Soluble blood flour, bone meal, soluble starch, malt flour, dried skim milk, corn meal, linseed meal, and flour middlings.
			F 18.9	4.2	3.	Wheat middlings, corn meal, linseed meal, malt flour, soluble starch (corn), dried skim milk, blood meal, bone meal.
6390	The Blatchford Calf Meal Factory, Waukegan, Ill. "Blatchford's Calf Meal"	Attica	G 24.	5.	6.75	Locust bean meal, unpressed flax seed, wheat flour, barley meal, ground beans and peas, rice polish, old process oil meal, cocoa shell meal, cocoanut meal, recleaned cottonseed meal, fenugreek, dried milk, anise and salt.
			F 24.1	5.2	6.2	As certified.

7909	Clover Leaf Milling Co., Buffalo, N. Y. "Clover Leaf Calf Meal"	Warsaw	G 25.	6.	7.	Wheat flour, pulverized malt flour, linseed meal, cottonseed meal and small percentage of salt.
			F 28.5	4.7	5.2	As certified.
8449	Edwards & Loomis Co., Chicago, Ill. "Red Horn Calf Meal"	Geneva	G 25.	5.	6.	Carob beans, flaxseed, wheat flour, cottonseed meal, beans and lentils, fenugreek, anise, cocoa meal, trace of salt.
			F 24.9	5.	5.7	Carob bean meal, flaxseed meal, cottonseed meal, beans and lentils, fenugreek, anise, ground cocoa shells, a trace of salt.
8530	The Empire Grain & Elevator Co., Binghamton, N. Y. "Empire Calf Meal"	Binghamton	G 18.75	8.	9.75	Wheat flour, recleaned cottonseed meal, linseed oil meal, crushed flaxseed, ground anise, ground cocoa shells, salt, rice bran, ground barley, rice polish, oat meal, locust bean meal, corn meal.
			F 17.8	7.1	9.9	As certified.
7086	International Stock Food Co., Minneapolis, Minn. "Grofast Calf Meal"	Sidney Center	G 25.	5.	10.	
			F 25.9	4.9	8.2	Fenugreek, locust bean meal, linseed meal, wheat flour, ground grain screenings.
8180	International Stock Food Co., Minneapolis, Minn. "International Grofast Calf Meal"	Stormville	G 25.	5.	10.	Foenugreek seed, locust bean, linseed oil meal, cleaned grain screenings, red dog flour.
			F 26.1	6.3	8.2	Fenugreek, locust bean meal, linseed meal, flaxseed, pea meal, red dog flour, ground grain screenings.
0586	Merrell-Soule Co., Syracuse, N. Y. "Merrell-Soule Calf Food"	Arcade	G 19.	4.5	5.	Milk powder, linseed meal, oat meal, cottonseed meal, wheat bran.
			F 22.3	5.4	4.4	As certified.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	CALF MEALS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*	
7883	The Park & Pollard Co., Boston, Mass. "Park & Pollard Co., Calf Meal"	Kirkville	G* 25.	5.	6.	Flaxseed, beans and lentils, wheat flour, cottonseed meal, locust beans, cocoa meal, anise, fenugreek, trace of salt.
			F* 24.7	6.	5.3	Ground flaxseed, beans and lentils, wheat flour, cottonseed meal, locust bean meal, ground cocoa shells, anise, fenugreek, salt.
6381	The Quaker Oats Co., Chicago, Ill. "Schumacher Calf Meal"	Attica	G 19.	8.	3.	Oat meal, wheat meal, ground flaxseed, dried casein, cottonseed meal, one-half of one per ct. bi-carbonate of soda.
			F 19.2	8.9	2.2	As certified.
8215	Ryde & Co., Chicago, Ill. "Ryde's Cream Calf Meal"	Boonville	G 25.	5.	6.	Carob beans, flaxseed, wheat flour, cottonseed meal, beans and lentils, fenugreek, anise, cocoa meal, trace of salt.
			F 24.1	4.8	5.6	Carob or locust bean meal, flaxseed meal, wheat flour, cottonseed meal, ground cocoa shells, beans and lentils, fenugreek, anise, trace of salt.
7890	Security Remedy Co., Mineapolis, Minn. "Security Calf Food Compound"	Marathon	G —	—	—	
			F 15.2	4.0	4.3	Wheat middlings, locust bean meal, fenugreek, anise, ginger, Venetian red, copperas, salt, sugar, corn starch.
	ANIMAL PRODUCTS:					
0169	Albany Rendering Co., Albany, N. Y. "Albany Bone & Meat Meal for Poultry"	Albany	G 35.	8.	—	
			F 33.	9.2	—	Meat and bone meal.

06	Albany Rendering Co., Albany, N. Y. "Albany Poultry Feed"	Grand Gorge	G	40.	8.	——	Cooked meat and bone scraps.
			F	39.5	11.9	——	Meat and bone scrap.
7586	Albany Rendering Co., Albany, N. Y. "Albany Poultry Food Prepared from Cooked Meat and Bone Scrap"	Chatham	G	40.	8.	——	Meat and bone.
			F	40.6	20.2	——	Meat and bone scrap.
8186	American Agr'l Chemical Co., New York, N. Y. "Ground Meat Scraps"	Brewster	G	45.	10.	——	Made from meat scraps.
			F	50.6	11.8	——	Meat scrap.
7591	American Agr'l Chemical Co., New York, N. Y. "Pure Ground Meat Scraps"	Irvington	G	55.	10.	——	Meat scraps.
			F	57.2	12.5	——	Meat scrap.
8561	The Animal Products Co., Philadelphia, Pa. "The APCO Poultry Meat"	Marathon	G	50.	11.	3.	
			F	50.7	11.4	——	Meat and bone scrap.
0253	Atterbury Bros., New York, N. Y. "Bent's Milk Albumen for Poultry"	Antwerp	G	——	——	——	Made from skim milk.
			F	74.8	0.9	——	Milk albumen.
8175	Baugh & Sons Co., Baltimore, Md. "Baugh's Meat Meal for Poultry"	Hopewell Jct.	G	50.	14.	1.	Ground pure beef cracklings.
			F	47.7	19.6	——	Beef cracklings.
8620	The Bent-Croissant Co., Antwerp, N. Y. "Bent's Milk Albumen (for Poultry)	Syracuse	G	43.	1.	——	
			F	38.3	12.1	——	Milk albumen.
7295	The Berg Company, Philadelphia, Pa. "3 Medal Beef Scraps"	Buffalo	G	50.	13.	3.	
			F	37.8	13.	——	Meat and bone scrap.
7912	The Berg Co., Philadelphia, Pa. "Berg's 3 Medal Beef Scraps"	Warsaw	G	50.	13.	3.	
			F	37.3	13.2	——	Meat and bone scrap.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	ANIMAL PRODUCTS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
8709	Bowker Fertilizer Co., New York, N. Y. "Bowker's Animal Meal"	Buffalo	G* 40. F* 51.4	5. 9.9	15. ——	Meat and bone. Meat meal.
8814	Burlington Rendering Co., Burlington, Vt. "Burlington Poultry Feed Prepared from Cooked Meat and Bone Scraps"	Glens Falls	G 40. F 41.3	8. 10.	—— ——	Meat and bone scrap.
7299	Cyphers Incubator Co., Buffalo, N. Y. "High Protein Meat Scraps for Poultry"	Dunkirk	G 45. F 38.	10. 9.3	—— ——	Meat and bone scrap.
8710	Darling & Co., Chicago, Ill. "Darling's Meat Crisps"	Buffalo	G 75. F 78.1	0.5 6.8	3. ——	Meat scrap.
8410	Jacob Dold Packing Co., Buffalo, N. Y. "Dold Quality Digestive Tankage"	Clyde	G 60. F 59.9	8. 10.6	5. ——	Digester tankage.
0757	Jacob Dold Packing Co., Buffalo, N. Y. "Dold Quality Meat and Bone Meal"	Buffalo	G 46. F 48.7	10. 13.1	5. ——	Meat meal.
7826	Jacob Dold Packing Co., Buffalo, N. Y. "Dold Quality Meat and Bone Scrap"	Owego	G 50. F 52.9	8. 8.6	5. ——	Scraps of meat cooked and dried. Meat scrap.

8722	Jacob Dold Packing Co., Buffalo, N. Y. "Dold Quality No. 2 Meat and Bone Scrap"	Jamestown	G	45.	8.	5.	
			F	46.3	9.4	——	Meat scrap
8526	Jacob Dold Packing Co., Buffalo, N. Y. "Dold Quality Soluble Blood Flour"	Earlville	G	85.	——	5.	
			F	84.3	0.5	——	Blood meal.
7840	Geo. M. Finn, Syracuse, N. Y. "Chicken Feed"	Syracuse	G	35.	15.	——	Ground meat and bone scrap.
			F	37.9	18.7	——	Meat scrap.
7931	The Flavell Co., Asbury Park, N. J. "Vim Pure Beef Cracklings"	Castile	G	50.	15.	3.	
			F	51.4	17.	——	Meat scrap.
8171	The L. T. Frisbie Co., New Haven, Conn. "Frisbie's Poultry Feed (Prepared from Cooked Meat and Bone Scraps)"	Beacon	G	40.	8.	——	Meat and bone scraps.
			F	37.	15.5	——	Meat and bone scrap.
8425	George L. Harding, Binghamton, N. Y. "Harding's 'Uncle Sam' Granulated Milk for Poultry"	Elmira	G	40.	5.	——	Made from dried skimmed milk whey.
			F	48.1	2.0	——	By-product from skim milk whey, containing protein, fat and phosphates.
073	Harvey Seed Co., Buffalo, N. Y. "Harvey's Meat Scraps and Bone"	Buffalo	G	45.	10.	——	
			F	47.8	14.3	——	Meat scrap.
0640	Innis Speeden & Co., New York, N. Y. "Eg-O Milk Albumen"	New York City	G	50.	1.		A by-product of milk sugar.
			F	50.	0.8	——	Milk albumen.
7552	International Glue Co., Boston, Mass. "Red Star Brand Fish Scraps"	White Plains	G	45.	2.	——	Fresh fish scrap.
			F	45.3	1.8	——	Fish scrap.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	ANIMAL PRODUCTS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
8826	Lowell Fertilizer Co., Boston, Mass. "Lowell Bone and Meat Meal for Poultry and Hogs"	Saratoga Springs	G* 35. F* 50.4	8. 10.	—— ——	Meat meal.
7832	Lowell Fertilizer Co., Boston, Mass. "Lowell Poultry Food"	Skaneateles	G 40. F 45.8	8. 11.6	—— ——	Cooked meat and bone scraps. Meat scrap.
07	Lowell Fertilizer Co., Boston, Mass. "Lowell Poultry Food"	Grand Gorge	G 40. F 42.1	8. 10.8	—— ——	Cooked meat and bone scraps. Meat and bone scrap.
7593	George E. McCoy, Peekskill, N. Y. "Evaporated Bone and Meat Meal for Poultry"	Peekskill	G 31. F 32.3	5. 5.8	1.05 ——	Animal matter. Bone and meat meal.
8026	Martin R. Maurer, Elisabeth, N. J. "Maurer's Kwality Meat and Bone Scraps"	Hempstead	G 50. F 52.5	10. 14.6	—— ——	Meat scrap.
8161	The Park & Pollard Co., Boston, Mass. "Blue Ribbon Meat Scraps"	Beacon	G 45. F 36.6	13. 15.4	2. ——	Meat scraps. Meat and bone scrap.
7820	Quaker City Mfg. Co., Philadelphia, Pa. "Quaker City Brand Beef Scraps"	Newark Valley	G 50. F 47.3	10. 10.1	2. ——	Meat and bone scrap.

8483	Robert A. Reichard, Allentown, Pa. "Reichard's High Grade Beef Scrap"	Caledonia	G F	55. 56.2	10. 16.1	3. ——	Beef scrap.
7557	Smith, Angevine & Co., Inc., Port Chester, N. Y. "Smith's Ground Meat and Bone Scrap for Poultry"	White Plains	G F	49.69 46.7	13.78 14.4	2.75 ——	Meat and bone scraps. Meat scrap.
8730	Spratt's Patent (Am.) Ltd., Newark, N. J. "Spratt's Patent Ground Meat"	Jamestown	G F	43. 43.1	11. 10.8	2. ——	Ground meat. Meat scrap.
8246	H. M. Stanton, Schenectady, N. Y. "Ground Beef and Bone Scraps"	Schenevus	G F	30. 37.9	15. 7.5	—— ——	Beef and bone. Meat and bone scrap.
0624	Swift & Company Chicago, Ill. "Swift's Digester Tankage"	Brooklyn	G F	60. 60.	8. 8.5	3. ——	Digester tankage.
8043	Swift & Co., Newark, N. J. "Swift's Eureka Meat Scraps"	Valley Stream	G F	50. 51.1	8. 11.	3. ——	Meat scrap.
8129	Swift & Co., Chicago, Ill. "Swift's Laymore Meat Scraps"	Poughkeepsie	G F	40. 41.3	8. 10.6	3. ——	Meat residue. Meat and bone scrap.
0566	Swift & Company, Chicago, Ill. "Swift's Meat Scraps"	Mayville	G F	50. 51.0	8. 10.6	3. ——	Meat scrap.
8304	Syracuse Rendering Co., Syracuse, N. Y. "Syracuse Bone Meal for Cattle and Poultry"	Oswego	G F	20. 24.6	5. 10.7	—— ——	Bone meal. Bone meal.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	ANIMAL PRODUCTS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*	
8625	Syracuse Rendering Co., Syracuse, N. Y. "Syracuse Bone and Meat Meal for Poultry"	Syracuse	G* 35. F* 42.	8. 9.1	—— ——	Meat and bone meal.
7891	Syracuse Rendering Co., Syracuse, N. Y. "Syracuse Poultry Food Prepared from Cooked Meat & Bone Scraps (Animal Products)"	Cincinnatus	G 40. F 40.8	8. 11.2	—— ——	Meat and bone scrap.
6795	Syracuse Rendering Co., Syracuse, N. Y. "Syracuse Poultry Food"	Genoa	G 40. F 40.3	8. 10 6	—— ——	Cooked meat and bone scraps. Meat and bone scrap.
0152	The Van Iderstine Co., Long Island City, N. Y. "Darling's Blood Meal for Poultry"	L. I. City	G 80. F 80.6	.1 0.8	—— ——	Blood meal.
8208	The Van Iderstine Co., Long Island City, N. Y. "Darling's High Protein Meat Scraps for Poultry"	Utica	G 55. F 56.2	5. 11.4	3. ——	Meat scrap.
0608	The Van Iderstine Co., Long Island City, N. Y. "Darling's 40% Protein Digester Tankage"	L. I. City	G 40. F 50.1	1. 1.8	3.5 ——	Digester tankage.

0609	The Van Iderstine Co., Long Island City, N. Y. "Darling's 60% Protein Digester Tankage"	L. I. City	G 60. F 62.3	1. 0.9	3. ——	Digester tankage.
7325	The Van Iderstine Co., Long Island City, N. Y. "Darling's Pure Ground Meat Scraps for Poultry"	Ellicottville	G 45. F 51.5	5. 8.8	3. ——	Meat scrap.
6790	Waterloo Soap Works, H. F. Brehm, Prop., Waterloo, N. Y. "Brehm's Beef Scrap and Bone"	Auburn	G 36. F 37.9	15. 21.3	—— ——	Sweet cleaned beef cracklings with enough sound bone to build up growing chicks and form eggs. Beef cracklings.
8055	Waterloo Soap Works, Waterloo, N. Y. "Brehm's Beef Scrap and Bone"	Northport	G 36. F 38.	15. 18.5	—— ——	Meat and bone scrap.
7978	M. J. Zonnevylle, Rochester, N. Y. "Pure Beef Scrap"	Rochester	G —— F 45.9	—— 22.8	—— ——	Made from pure cooked beef scrap. Beef scrap.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	ALFALFA MEAL:		*Per ct.*	*Per ct.*	*Per ct.*
059	The Consolidated Alfalfa Milling Co., Newton, Kans. "Pure Alfalfa Meal"	Elba	G* 14. F* 14.3	1.2 1.4	33.3 29.6
8711	The Denver Alfalfa Milling & Product Co., Hartman, Colo. "Alfalfa Meal"	Buffalo	G 12. F 14.1	1.5 1.6	35. 29.7
7935	The Albert Dickinson Co., Chicago, Ill. "Alfalfa Meal"	Hornell	G 12. F 12.	1. 1.3	35. 34.1
8573	Edwards & Loomis Co., Chicago, Ill. "Red Comb Alfalfa Meal"	Ithaca	G 13.5 F 14.7	1. 1.7	35. 28.
8503	A. F. Fietz, Munnsville, N. Y. "Alfalfa Meal"	Oneida	G 12. F 12.6	1. 1.3	35. 29.4
0552	The Gates Elevator Co., Cleveland, O. "Alfalfa Meal"	Brocton	G —— F 15.9	—— 1.5	—— 26.9
7592	The Grange Co., Modesto, Cal. "Modesto Alfalfa Meal"	New Rochelle	G 15. F 14.2	1.5 1.7	30. 26.5
7969	Harvey Seed Co., Buffalo, N. Y. "Alfalfa Meal"	Spencerport	G 12. F 17.2	1. 1.9	30. 21.3
8701	Haywood Alfalfa Warehouse Co., Kansas City, Mo. "'Algren' Alfalfa Meal"	Portville	G 12. F 14.1	1. 1.3	35. 28.8
6793	Kornfalfa Feed Milling Co., Kansas City, Mo. "Pioneer Alfalfa Meal"	Auburn	G 12. F 13.8	1.5 1.5	35. 27.2
7821	Kornfalfa Feed Milling Co., Kansas City, Mo. "Pioneer Alfalfa Meal"	Newark Valley	G 12. F 13.9	1.5 1.5	35. 23.
0375	Kornfalfa Feed Milling Co., Kansas City, Mo. "Pioneer Alfalfa Meal"	Middletown	G 12. F 13.9	1.5 1.8	35. 25.4

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
	ALFALFA MEAL (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*
0177	Lovejoy Brothers, Berthoud, Colo. "Alfalfa Meal"	Kingston	G* 13. F* 16.1	1. 1.6	30. 27.1
8458	Lovejoy Brothers, Berthoud, Colo. "Alfalfa Meal"	Lyons	G 13. F 14.3	1. 1.6	30. 31.2
7846	National Feed Co., St. Louis, Mo "Pure Alfalfa Meal'	Syracuse	G 14. F 15.3	1.25 1.8	33. 22.9
8139	Omaha Alfalfa Milling Co Omaha, Neb. "Alfalfa Meal"	Poughkeepsie	G 12. F 12.8	1. 1.6	30. 29.9
7095	The Park & Pollard Co., Boston, Mass. "Alfalfa"	Liberty	G 12. F 15.6	1.5 1.6	30. 25.2
7922	M. C. Peters Mill Co., Omaha, Neb. "Peters Lucern Alfalfa Meal"	Perry	G 12. F 13.	.5 1.4	33. 29.1
8808	Purina Mills, St. Louis, Mo. "Purina Alfalfa Meal"	Fort Edward	G 14. F 16.6	1.5 1.7	29. 24.7
8033	Scott, Magner & Miller, San Francisco, Cal "California Alfalfa Meal"	Valley Stream	G 15.31 F 14.3	1.98 1.7	25.33 29.2
7551	Somers & Co., San Francisco, Cal. "Red Star Brand Alfalfa Meal"	White Plains	G 16.6 F 14.6	1.4 1.4	29.5 27.5
8140	The Otto Weiss Alfalfa Stock Food Co., Wichita, Kans. "Pure Dustless Alfalfa Meal"	Poughkeepsie	G 14. F 12.9	1.5 1.3	30. 31.8
0358	Not given "Alfalfa"	Johnstown	G —— F 15.5	—— 1.8	—— 30.1

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BY-PRODUCTS — WHEAT BRAN:		*Per ct.*	*Per ct.*	*Per ct.*	
057	Acme-Evans Co., Indianapolis, Ind. "Acme Bran"	Castile	G* 15.5	4.	10.	Wheat bran and not exceeding mills run of ground cleaned wheat screenings.
			F* 16.3	4.5	8.2	Wheat bran, ground screenings.
8716	Acme Evans Co., Indianapolis, Ind. "Acme Bran"	Randolph	G 15.5	4.	10.	Wheat bran and not exceeding mills run of ground cleaned wheat screenings.
			F 16.3	4.3	8.	Wheat bran containing traces of ground screenings.
8747	Acme Milling Co., Olean, N. Y. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Olean	G 15.38	4.05	5.65	
			F 15.2	4.5	11.	Wheat bran, ground screenings.
0372	The Ætna Mills Co., Wellington, Kans. "Wheat Bran"	Voorheesville	G 14.5	3.5	10.	
			F 17.5	4.7	8.6	Wheat bran.
0565	Ames-Burns Co., Jamestown, N. Y. "Blue Tag Choice Winter Bran with Ground Screenings not Exceeding Mill Run"	Mayville	G 14.	3.	10.	
			F 17.5	4.5	9.5	Wheat bran containing traces of ground screenings.
8216	Ames-Burns Co., Jamestown, N. Y. "Perfection Extra Fancy Winter Bran"	Boonville	G 14.	4.	10.	Pure winter wheat product.
			F 16.3	4.7	7.5	Wheat bran.

7032	Atlas Flour Mills, Milwaukee, Wis. "Atlas Wheat Bran with Ground Screenings not Exceeding Mill Run"	McLean	G F	13. 15.3	3. 4.3	11. 8.8	Wheat bran, ground screenings.
8212	Bay State Milling Co., Winona, Minn. "Winona Coarse Wheat Bran"	Boonville	G F	16. 16.	5. 5.	11. 10.1	Wheat bran.
8539	Bernet, Craft & Kauffman Mlg. Co., St. Louis, Mo. "Wheat Bran with Screenings not Exceeding Mill Run"	Haynes	G F	14. 15.8	3. 4.5	—— 9.2	Wheat bran and screenings not exceeding mill run. Wheat bran containing a trace of ground screenings.
0554	Bernet, Craft & Kauffman Mlg. Co., St. Louis, Mo. "Wheat Bran with Screenings not Exceeding Mill Run"	Jamestown	G F	14.3 16.4	3.55 5.3	—— 8.4	Wheat bran containing a small amount of screenings.
8825	Big Diamond Mills Co., Minneapolis, Minn. "Big Diamond Wheat Bran with Ground Screenings not Exceeding Mill Run"	Saratoga Springs	G F	14. 14.4	4. 4.9	11.07 10.2	Wheat bran, ground screenings.
7039	Big Diamond Mills Co., Minneapolis, Minn. "Big Diamond Wheat Bran with Ground Screenings not Exceeding Mill Run"	Little York	G F	14. 14.8	4. 4.7	11.07 8.6	Wheat bran, ground screenings.
7374	Bill, Bell & Co., Ogdensburg, N. Y. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Ogdensburg	G F	14.25 17.3	4.1 5.2	11.75 6.5	Ground screenings not exceeding mill run. Wheat bran, ground screenings.
7858	The Birkett Mills, Penn Yan, N. Y. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Trumansburg	G F	14.25 14.3	4. 4.7	9.5 8.2	Wheat bran containing small amounts of ground screenings and cockle bran.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	WHEAT BY-PRODUCTS — WHEAT BRAN (*continued*):					
8082	S. W. Bowne Co., Brooklyn, N. Y. "Wheat Bran and Mill Run Screenings"	Brooklyn	G* 13. F* 13.8	4. 4.	14. 10.3	Wheat and mill run screenings. Wheat bran, ground screenings.
8558	J. P. Burroughs & Son, Flint, Mich. "Choice Winter Bran"	Whitney Point	G —— F 13.7	—— 4.3	—— 7.6	With ground screenings not exceeding mill run. Wheat bran, ground screenings.
0642	Cannon Valley Milling Co., Minneapolis, Minn. "C. V. Wheat Bran with Ground Screenings not Exceeding Mill Run"	Jamaica	G 16.1 F 14.5	4. 5.6	14.6 9.8	Wheat bran containing a small amount of ground screenings.
8824	Cannon Valley Milling Co., Minneapolis, Minn. "C. V. Wheat Bran with Ground Screenings not Exceeding Mill Run"	Saratoga Springs	G 13. F 14.6	4. 5.	13. 10.2	Wheat bran, ground screenings.
7901	Cataract City Milling Co., Niagara Falls, N. Y. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Warsaw	G 13.8 F 17.1	4.8 8.3	—— 8.6	Wheat bran, ground screenings.
8323	The Cherokee Mills, Cherokee, Okla. "Wheat Bran"	Pennellville	G 15. F 17.7	3.5 4.3	10. 8.6	Wheat bran.
7396	Geo. C. Christian, Minneapolis, Minn. "Jersey Wheat Bran with Ground Screenings not Exceeding Mill Run"	Redwood	G 13. F 13.4	4. 4.9	12. 8.5	Ground screenings not exceeding mill run. Wheat bran, ground screenings.

7553	Geo. C. Christian, Minneapolis, Minn. "Jersey Wheat Bran with Ground Screenings not Exceeding Mill Run"	White Plains	G 13. F 14.3	4. 5.1	12. 10.	Wheat product. Wheat bran, ground screenings.
0383	The Cleveland Milling Co., Cleveland, O. "Spring Wheat Bran with Ground Screenings not Exceeding Mill Run"	Kingston	G 14. F 14.5	4.5 5.6	12. 8.4	 Wheat bran, ground screenings.
8418	The Cleveland Milling Co., Cleveland, O. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Elmira	G 14. F 14.9	4.5 4.7	13. 8.1	 Wheat bran containing traces of ground screenings.
8280	Claro Milling Co., Lakeville, Minn. "Claro Wheat Bran with Ground Screenings"	Rome	G 14. F 4.5	3. 4.8	12. 9.9	Wheat bran with ground screenings not exceeding mill run. Wheat bran, ground screenings.
099	Colburn Bros. Co., McPherson, Kans. "Wheat Bran and Screenings"	Fredonia	G 14.5 F 17.	3.5 4.5	10. 9.4	 Wheat bran.
8110	H. C. Cole Milling Co., Chester, Ill. "Bran — Product of Pure Soft Winter Wheat with Ground Screenings not Exceeding Mill Run"	Poughkeepsie	G 14.5 F 16.3	4. 4.9	9.5 6.9	Product of winter wheat, wheat bran only. Wheat bran containing traces of ground screenings.
7027	Commander Mill Co., Minneapolis, Minn. "Commander Wheat Bran with Ground Screenings not Exceeding Mill Run"	Cortland	G 14. F 14.5	4. 4.9	11. 9.8	 Wheat bran, ground screenings.
8547	The Commercial Milling Co., Detroit, Mich. "Wheat Bran"	Binghamton	G 14.5 F 15.4	3.5 4.9	12. 8.9	 Wheat bran.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BY-PRODUCTS — WHEAT BRAN (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
8549	Wm. A. Coombs Milling Co., Coldwater, Mich. "Wheat Bran"	Owego	G* 14. F* 14.9	3. 4.8	10. 9.1	Wheat bran with ground screenings not exceeding mill run. Wheat bran containing a trace of ground screenings.
7950	William G. Crocker, Minneapolis, Minn. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Canaseraga	G 14.5 F 15.1	4. 5.2	12. 9.5	Wheat bran, ground screenings.
0582	Crouch Bros. Co., Erie, Pa. "Crouch Bros. Co. Wheat Bran with Ground Screenings not Exceeding Mill Run"	Franklinville	G 15. F 14.9	5. 5.9	9. 7.9	Wheat bran, ground screenings.
0553	Crouch Bros. Co., Erie, Pa. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Jamestown	G 15. F 14.7	5. 5.9	9. 8.	Wheat bran, ground screenings.
8865	J. G. Davis Co., Rochester, N. Y. "Choice Wheat Bran, Granite Brand"	Richmondville	G 14. F 16.8	3. 5.1	12. 8.7	Wheat bran containing a small amount of ground screenings.
8312	J. G. Davis Co., Rochester, N. Y. "Choice Wheat Bran, Granite Brand"	Croghan	G 14. F 16.	3. 5.	12. 8.3	Choice wheat bran. Wheat bran containing a trace of ground screenings.
8211	Delphos Milling Co., Delphos, Kan. "Pure Winter Wheat Bran"	Boonville	G 14.5 F 16.	4. 4.4	11. 9.9	Made from pure wheat. Wheat bran.

8041	Eagle Roller Mills Co., New Ulm, Minn. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Valley Stream	G 15.45 F 15.5	3.43 5.1	11.5 10.2	Wheat bran containing traces of ground screenings.
7313	E. A. Eckhart Milling Co., Chicago, Ill. "Bran with Ground Screenings not Exceeding Mill Run"	Salamanca	G 14. F 17.1	4. 4.2	11. 7.6	Wheat bran, ground screenings.
8436	Elevator Roller Mills, Columbus, Neb. "Bran & Scourings Mill Run"	Kanoa	G 13. F 16.4	3. 4.7	12. 8.2	Wheat bran and scourings.
6648	Ellinwood Mill & Elevator, Ellinwod, Kans. "White Lily Wheat Bran & Screenings"	Salem	G 14. F 16.5	3. 4.4	14. 8.6	Wheat bran containing a trace of ground screenings.
08	Empire Grain & Elevator Co., Binghamton, N. Y. "Russell Miller Milling Co. Bran"	Sidney	G 13. F 16.1	4. 5.4	11. 9.4	Made from wheat only. Wheat bran.
8406	Everett, Aughenbaugh & Co., Waseca, Minn. "E-A-Co Wheat Bran with Ground Screenings not Exceeding Mill Run"	Port Byron	G 14. F 16.	3. 5.1	12. 9.8	Wheat bran, ground screenings.
7927	Evart & Lake, Groveland, N. Y. "Wheat Bran, Mixed with Ground Screenings not Exceeding Mill Run"	Castile	G 15. F 16.8	3.5 4.8	10. 6.1	Wheat bran containing a trace of ground screenings.
8543	Fairview Mill Co., Fairview, Mont. "The Yellowstone Valley Mills Bran"	Binghamton	G 16.5 F 14.4	4.6 5.1	10.2 9.4	Wheat bran containing a trace of ground screenings.
013	The Farmers Co-operative Co., Defiance, O. "Bran"	Sidney	G —— F 15.	—— 4.5	—— 3.8	Wheat bran.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BY-PRODUCTS —WHEAT BRAN (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
7963	Federal Milling Co., Lockport, N. Y. "Dairy Maid Winter Wheat Bran with Ground Screenings not Exceeding Mill Run"	Brockport	G* 14.5 F* 14.3	4. 4.6	10. 8.8	Wheat bran, ground screenings.
6379	Federal Milling Co., Lockport, N. Y. "Lucky Spring Wheat Bran with Ground Screenings not Exceeding Mill Run"	Batavia	G 15. F 16.1	4.5 5.7	11. 9.1	Wheat bran, ground screenings.
8305	James Frasee Milling Co., Baldwinsville, N. Y. "Frazee's Fancy Bran"	Oswego	G —— F 14.4	—— 4.5	—— 9.6	Wheat bran, traces of cockle bran.
8263	The Gardner Mills, Hastings, Minn. "AXA Bran"	Wells Bridge	G 14. F 16.4	3.7 3.7	13.5 7.1	Wheat bran containing traces of ground screenings.
6644	Gooch Milling & Elevator Co., Lincoln, Neb. "Wheat Bran with Ground Screenings"	Ballston Spa.	G 15.52 F 15.9	2.5 4.4	10.62 9.4	Wheat bran containing a small amount of ground screenings.
7957	Wm. Hamilton & Son, Honeoye Falls, N. Y. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Caledonia	G 14.45 F 13.6	4.25 4.5	9.08 8.7	Wheat bran, ground screenings.
7916	Hecker-Jones-Jewell Milling Co., Buffalo, N. Y. "Choice Wheat Bran with Trace of Screenings"	Silver Springs	G 15. F 16.5	3.5 5.1	11.75 9.3	Made from pure wheat. Wheat bran, ground screenings.

7392	A. H. Herrick & Son, Watertown, N. Y. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Watertown	G 14.5 F 16.6	3. 5.8	12. 6.6	Wheat bran, ground screenings.
7391	A. H. Herrick & Son, Watertown, N. Y. "Herrick's Standard Middlings with Ground Screenings not Exceeding Mill Run"	Watertown	G 15. F 15.9	5. 5.8	8. 3.5	Wheat middlings containing traces of ground screenings.
7787	J. A. Hinds & Co., Rochester, N. Y. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Ilion	G 14.5 F 15.9	4.2 5.2	11.3 8.7	Wheat bran, ground screenings.
8299	The Hoffman Mills, Enterprise, Kans. "Wheat Bran"	Central Square	G 14.7 F 17.	4.45 4.3	10. 10.	Wheat bran.
0377	The Hogan Milling Co., Junction City, Kans. "Bran & Screenings"	Middletown	G 14.5 F 16.4	3.5 4.5	10. 9.5	Bran and screenings. Screenings not more than one per ct. Wheat bran, ground screenings.
7599	Hubbard Milling Co., Mankato, Minn. "Flaky Bran, Wheat Bran with Ground Screenings not Exceeding Mill Run"	Shekomeko	G 15. F 14.7	4.8 5.3	11.5 9.4	Wheat bran with ground screenings not exceeding mill run. Wheat bran, ground screenings.
7380	Hubbard Milling Co., Mankato, Minn. "Flaky Bran with Ground Screenings not Exceeding Mill Run"	Massena	G 15. F 16.9	4.8 5.	11.5 5.9	Wheat bran with ground screenings not exceeding mill run. Wheat bran, ground screenings.
7870	Hunter-Robinson-Wenz Milling Co., St. Louis, Mo. "Dreadnought Extra Coarse Wheat Bran with Ground Screenings not Exceeding Mill Run"	Truxton	G 15.5 F 16.4	4. 4.5	11. 8.5	Wheat bran containing traces of ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BY-PRODUCTS —WHEAT BRAN (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
0574	Hunter-Robinson-Wenz Milling Co., St. Louis, Mo. "Dreadnought Extra Coarse Wheat Bran with Ground Screenings not Exceeding Mill Run"	Olean	G* 15.5 F* 15.8	4. 5.3	11. 8.	Wheat bran.
7597	Hunter-Robinson-Wenz Milling Co., St. Louis, Mo. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Katonah	G 15.5 F 16.5	4. 4.4	11. 8.5	Wheat bran.
6639	Hunter-Robinson-Wenz Milling Co., St. Louis, Mo. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Glens Falls	G 15.5 F 15.4	4. 4.8	11. 9.7	Wheat bran, ground screenings.
0556	W. J. Jennison Co., Minneapolis, Minn. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Jamestown	G 15. F 14.9	4. 5.2	10. 10.5	Wheat bran, ground screenings.
7918	Kemper Mill & Elevator Co., Kansas City, Mo. "Anchor Bran with Ground Screenings not Exceeding Mill Run"	Perry	G 14.5 F 15.9	4. 4.5	10. 9.6	Bran and ground wheat screenings. Wheat bran, ground screenings.
7849	Kemper Mill & Elevator Co., Kansas City, Mo. "Diamond K Bran with Ground Wheat Screenings not Exceeding Mill Run"	Georgetown Station	G 14.5 F 17.2	4. 4.6	9.5 7.8	Wheat bran containing traces of ground screenings.

0551	John B. A. Kern & Sons, Milwaukee, Wis. "Eagle Wheat Bran with Ground Screenings not Exceeding Mill Run"	Brocton	G 13 F 14.7	3. 4.5	10. 9.8	Wheat bran, ground screenings.
8024	Keusch & Schwartz Co., Inc., New York, N. Y. "K. & S. Wheat Bran and Mill Run Screenings"	Mineola	G 14.5 F 15.4	4. 5.1	12. 9.6	Wheat bran and mill run screenings. Wheat bran, ground screenings.
0562	M. D. King Milling Co., Pittsfield, Ill. "King Soft Wheat Bran with Ground Screenings not Exceeding Mill Run"	Brocton	G 14. F 16.9	3.5 4.4	10. 9.2	Wheat bran, ground screenings.
8048	The Larabee Flour Mills Co., Hutchinson, Kans. "Wheat Bran with Mill Run Screenings not to Exceed 8 Per Cent"	New York	G 14.5 F 17.4	3.5 3.2	10. 9.2	Wheat bran containing a trace of ground screenings.
8845	The Larabee Flour Mills Co., Hutchinson, Kan. "Wheat Bran with Mill Run Screenings not to Exceed 8 Per Cent"	Cherry Valley	G 14.5 F 16.2	3.5 4.4	10. 9.2	Wheat bran. §
0171	Listman Mill Co., La Crosse, Wis. "Elmco Wheat Fancy Bran"	Goshen	G 15.69 F 15.1	3.88 5.	12.16 9.5	Wheat bran.
8441	Macauley-Fien Milling Co., Rochester, N. Y "Choice Wheat Bran with Mill Run Screenings."	Rochester	G 16. F 15.9	5. 5.8	8. 8.3	Wheat bran, ground screenings.
7975	Macauley-Fien Milling Co., Rochester, N. Y. "Choice Wheat Bran with Mill Run Screenings"	Charlotte	G 16. F 16.	5. 5.1	8. 7.5	Wheat bran containing traces of ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BY-PRODUCTS — WHEAT BRAN (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
6633	The Mansfield Milling Co., Inc., Mansfield, O. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Saratoga Spgs.	G* 13. F* 14.4	4. 5.7	13. 9.6	Wheat bran, ground screenings.
8204	Maple Leaf Milling Co., Toronto, Canada. "Maple Leaf Wheat Bran"	Mohawk	G 15.5 F 16.5	4.5 5.4	12. 10.	Wheat bran Wheat bran containing traces of ground screenings.
8867	Moseley & Motley Milling Co., Rochester, N. Y. "Choice Wheat Big B Bran"	Central Bridge	G —— F 15.2	—— 5.1	—— 9.4	Wheat bran, traces of cockle present.
7892	Moseley & Motley Milling Co., Rochester, N. Y. "Choice Wheat Big B Bran"	Syracuse	G —— F 15.	—— 5.2	—— 9.2	Wheat bran containing a trace of ground screenings."
0203	The National Milling Co., Toledo, O. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Rhinebeck	G 16.5 F 15.8	5.5 5.2	12.5 9.6	Wheat bran with ground screenings not exceeding mill run. Wheat bran, ground screenings.
8194	National Feed Co., St. Louis, Mo. "Wheat Bran with Screenings not Exceeding Mill Run"	Towners	G 14.5 F 16.3	4. 4.	10. 8.	Wheat bran and screenings only. Wheat bran.
9002	New Prague Flouring Mill Co., New Prague, Minn. "Seal of Minnesota Wheat Bran with Ground Screenings not Exceeding Mill Run"	Amsterdam	G 14.6 F 15.2	4.75 4.3	11. 9.9	Wheat bran, ground screenings.

7889	Niagara Falls Milling Co., Niagara Falls, N. Y. "Choice Wheat Bran"	Marathon	G F	14. 15.7	3. 5.2	13. 9.1	Wheat bran containing a trace of ground screenings.
7956	Niagara Falls Milling Co., Niagara Falls, N. Y. "Choice Wheat Bran"	Caledonia	G F	14. 16.2	3. 5.3	12. 8.5	Wheat bran containing traces of ground screenings.
8251	The Northwestern Consolidated Milling Co., Minneapolis, Minn. "Pure Wheat Bran"	Oneonta	G F	14.5 16.	4. 5.3	11. 9.5	Wheat bran.
8863	The Northwestern Consolidated Milling Co., Minneapolis, Minn. "Pure Wheat Bran"	Sharon Springs	G F	14.5 15.6	4. 4.9	11. 10.3	Wheat bran, traces of cockle present.
0180	Northwestern Consolidated Milling Co., Minneapolis, Minn. "Pure Wheat Bran"	Kingston	G F	14.5 15.6	4. 4.7	11. 10.2	Wheat bran.
7898	The Northwestern Consolidated Milling Co., Minneapolis, Minn. "Pure Wheat Bran, No Screenings, No Scourings."	Oran	G F	14.5 14.4	4. 4.9	11. 10.2	Wheat bran containing traces of cockle bran.
0634	Northwestern Elevator & Mill Co., Toledo, O. "Taylors Feed"	New York City	G F	13. 14.9	4. 4.7	6.5 8.8	Wheat bran with ground screenings not exceeding mill run. Wheat bran, ground screenings.
7366	Ogdensburg Roller Mills, Ogdensburg, N. Y. "Ogdensburg Roller Mills Wheat Bran with Ground Screenings not Exceeding Mill Run"	Ogdensburg	G F	14. 16.9	4. 5.4	11. 5.2	Wheat bran, ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BY-PRODUCTS — WHEAT BRAN (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
8446	Ontario Roller Mills, Fenton & Hawkins, Props., Canandaigua, N. Y. "Wheat Bran"	Canandaigua	G* —— F* 14.7	—— 4.3	—— 9.1	Wheat bran.
8314	Osakis Milling Co., Osakis, Minn. "Fancy Bran"	New Bremen	G 15. F 14.0	4. 4.3	11. 9.9	Wheat bran, traces of cockle bran.
8750	Phelps & Sibley Co., Cuba, N. Y. "Phelps & Sibley Co's Fancy Wheat Bran with Ground Screenings not Exceeding Mill Run"	Cuba	G 15. F 14.6	4. 4.7	10. 9.	Wheat bran containing traces of ground screenings.
063	Philip Houck Milling Co., Buffalo, N. Y. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Clarence	G —— F 15.	—— 6.1	—— 9.8	Wheat bran containing a small amount of cockle bran.
6800	Pillsbury Flour Mills Co., Minneapolis, Minn. "Pillsbury's Wheat Bran with Ground Screenings not Exceeding Mill Run"	Moravia	G 14.5 F 16.6	4. 5.6	12. 10.6	Wheat bran, ground screenings.
8235	Geo. P. Plant Milling Co., St. Louis, Mo. "Wheat Bran"	Whitesboro	G 15. F 16.2	3. 4.1	11. 9.6	Wheat bran with screenings not exceeding mill run. Wheat bran containing a trace of ground screenings.

0367	The Pratt Mills, Pratt, Kans. "Wheat Bran and Screenings not to Exceed 10 per ct. Screenings"	Kinderhook	G 14.5 F 16.4	3.5 4.2	10. 9.4	Wheat bran containing a small amount of ground screenings.
7576	Red Wing Milling Co., Red Wing, Minn. "Bixota Wheat Bran with Ground Screenings not Exceeding Mill Run"	Yonkers	G 14.1 F 14.8	4.1 4.7	12.7 7.4	Wheat bran with ground screenings not exceeding mill run. Wheat bran, ground screenings.
8484	The Red Star Mill & Elevator Co., Wichita, Kans. "Wheat Bran and Screenings"	Hornell	G 14.5 F 16.6	3.5 4.3	10. 9.4	Wheat bran and wheat screenings not to exceed eight per ct. screenings. Wheat bran, ground screenings.
8854	Red Wing Milling Co., Red Wing, Minn. "Bixota Wheat Bran with Ground Screenings not Exceeding Mill Run"	Delanson	G 14.1 F 14.5	4.1 4.7	12.7 10.5	Wheat bran, ground screenings.
8455	Rogers & Ryan, Rochester, N. Y. "Winter Wheat Bran"	Rochester	G —— F 13.8	—— 5.	—— 8.9	Wheat bran, traces of cockle present.
0580	Rush City Milling Co., Rush City, Minn. "Choice Wheat Bran with Ground Screenings not Exceeding Mill Run"	Olean	G 15. F 14.8	4. 5.2	10.6 9.9	Wheat bran containing a small amount of ground screenings.
8089	Russell-Miller Milling Co., Minneapolis, Minn. "Bran"	Guilderland Center	G 13. F 17.	4. 5.3	11. 9.	Made from pure wheat. Wheat bran.
8271	Russell Miller Milling Co., Minneapolis, Minn. "Bran"	Bridgewater	G 13. F 15.1	4. 5.2	11. 9.1	Made from wheat only. Wheat bran containing traces of ground screenings.
8623	Sauers Milling Co., Evansville, Ill. "Winter Wheat Bran with Ground Screenings not Exceeding Mill Run"	Syracuse	G 14. F 16.5	3. 4.7	10. 7.5	Wheat bran, ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BY-PRODUCTS — WHEAT BRAN (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
0590	Saxony Mills, St. Louis, Mo. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Collins	G* 12. F* 16.	3.5 4.6	10. 9.3	Wheat bran containing a trace of ground screenings.
8309	Sleepy Eye Flour Mills Co., Minneapolis, Minn. "Bran"	Crockett	G 15.3 F 14.8	4.4 4.8	13.3 9.9	Pure wheat. Wheat bran.
0373	The Southwestern Milling Co., Kansas City, Mo. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Voorheesville	G 16.16 F 17.3	3.58 4.7	10.22 8.2	Wheat bran.
8628	The Southwestern Milling Co., Kansas City, Mo. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Syracuse	G 16.16 F 16.9	3.58 4.7	10.22 8.2	Wheat bran.
8218	Standard-Tilton Milling Co., St. Louis, Mo. "Wheat Bran"	Boonville	G 14.5 F 17.3	4. 5.	9.5 8.8	Wheat bran with screenings not exceeding mill run. Wheat bran.
8319	Standard-Tilton Milling Co., St. Louis, Mo. "Wheat Bran with Screenings"	Carthage	G 14.5 F 17.9	4. 4.8	9.5 8.1	Wheat bran with screenings not exceeding mill run. Wheat bran.
0585	Star & Crescent Milling Co., Chicago, Ill. "Crescent Winter Wheat Bran with Ground Screenings not Exceeding Mill Run"	Franklinville	G 15. F 16.	4. 4.3	10. 8.3	Wheat bran.

0190	Bay State Milling Co., Winona, Minn. "Winona Fancy White Flour Middlings"	Ballston Lake	G	18.	4.5	3.	
			F	17.6	4.6	2.	Wheat white middlings.
7872	Big Diamond Mills Co., Minneapolis, Minn. "Big Diamond Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	Sheds Corners	G	14.67	4.21	9.35	
			F	18.0	5.5	6.8	Wheat middlings, ground screenings.
7564	Big Diamond Mills Co., Minneapolis, Minn. "Big Diamond Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	Port Chester	G	14.67	4.21	9.35	Wheat product.
			F	18.	5.1	5.4	Wheat middlings, ground screenings.
7375	Bill, Bell & Co., Ogdensburg, N. Y. "Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run"	Ogdensburg	G	16.5	5.	4.	Ground screenings not exceeding mill run.
			F	18.9	4.3	2.	Wheat middlings, containing traces of ground screenings.
7376	Bill, Bell & Co., Ogdensburg, N. Y. "Wheat Shorts with Ground Screenings not Exceeding Mill Run"	Ogdensburg	G	16.	5.	10.	Ground screenings not exceeding mill run.
			F	18.4	5.1	3.8	Wheat middlings containing traces of ground screenings.
8608	The Birkett Mills, Penn Yan, N. Y. "Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Genoa	G	15.75	4.	5.5	
			F	14.1	4.6	3.2	Wheat middlings containing traces of ground screenings.
0100	Blaine, Mackay, Lee Co., North East, Pa. "Pure Wheat Middlings with Mill Run Screenings"	Fredonia	G	16.	4.	6.	
			F	15.8	5.1	4.2	Wheat middlings, ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BY-PRODUCTS — WHEAT BRAN (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*	
054	Valier & Spies Milling Co., St. Louis, Mo. "Valier's Wheat Bran with Ground Screenings"	Arcade	G* 14.5 F* 17.3	3.5 5.1	10. 8.2	Five per ct. ground wheat screenings. Wheat bran containing a small amount of ground screenings.
8613	Valley City Milling Co., Grand Rapids, Mich. "Farmers' Favorite Choice Wheat Bran with Ground Screenings not Exceeding Mill Run"	Locke	G 15.92 F 14.6	3.9 4.6	9.75 10.6	Wheat bran, ground screenings.
8442	Van Vechten Milling Co., Inc., Rochester, N. Y. "Van Vex Winter Bran"	Rochester	G 15. F 14.6	4. 4.7	10. 8.9	Wheat bran
7992	Victor Milling Co., Victor, N. Y. "Victor Spring Wheat Bran with Ground Screenings not Exceeding Mill Run"	Canandaigua	G 14.6 F 16.6	4. 5.2	15. 8.9	Wheat bran, ground screenings.
7914	Washburn Mills, Buffalo, N. Y. "Washburn-Crosby Co's Wheat Bran with Ground Screenings not Exceeding Mill Run"	Silver Springs	G 14.5 F 16.8	4. 5.2	12. 9.8	Wheat bran, ground screenings.
7034	Washburn-Crosby Co., Buffalo, N. Y. "Wheat Bran with Ground Screenings not Exceeding Mill Run"	Groton	G 14.5 F 16.9	4. 5.2	12. 8.1	Wheat bran, ground screenings.

8737	Claro Milling Co., Waseca, Minn. "Claro Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	Wellsville	G F	14. 16.4	3. 5.9	12. 6.6	Wheat middlings, ground screenings.
0384	The Cleveland Milling Co., Cleveland, O. "Special Fine Middlings"	Kingston	G F	15. 14.9	5. 4.4	6. 2.6	Made from wheat with ground screenings not exceeding mill run. Wheat middlings, ground screenings.
0561	The Cleveland Milling Co., Cleveland, O. "Special Fine Middlings with Ground Screenings not Exceeding Mill Run"	Brocton	G F	15. 15.3	5. 5.4	6. 4.1	Wheat middlings, ground screenings.
0156	The Cleveland Milling Co., Cleveland, O. "Wheat Coarse Middlings with Ground Screenings not Exceeding Mill Run"	Catskill	G F	14. 16. 1	4.5 5.5	9. 7.1	Wheat middlings, ground screenings.
8426	The Cleveland Milling Co., Cleveland, O. "Wheat Coarse Middlings with Ground Screenings not Exceeding Mill Run"	Elmira	G F	14. 16.1	4.5 5.4	9. 6.9	Wheat middlings, ground screenings.
0154	The Cleveland Milling Co., Cleveland, O. "Wheat Fine Middlings with Ground Screenings not Exceeding Mill Run"	Catskill	G F	15. 16.1	3.5 4.9	6. 5.7	Wheat middlings, ground screenings.
8420	The Cleveland Milling Co., Cleveland, O. "Wheat Fine Middlings with Ground Screenings not Exceeding Mill Run"	Elmira	G F	15. 16.1	3.5 4.7	6. 4.1	Wheat middlings, ground screenings.
8334	Commander Mill Co., Minneapolis, Minn. "Battleship Low Grade"	Rome	G F	18. 15.7	4.5 4.2	4. 1.3	Wheat white middlings.

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	WHEAT MIDDLINGS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
8157	Atlas Flour Mills, Milwaukee, Wis. "Atlas Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run"	Pleasant Valley	G* 14. F* 16.9	3. 4.7	7. 6.6	Wheat product. Wheat middlings, ground screenings.
8618	Atlas Flour Mills, Milwaukee, Wis. "Standard Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Syracuse	G 13.5 F 14.9	3.5 5.1	10.5 8.8	Wheat middlings, ground screenings.
6393	Banner Milling Co., Buffalo, N. Y. "Banner Flour Midds, Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Darien Center	G 15. F 17.8	4.25 5.8	9.75 5.4	From wheat only. Wheat middlings, containing traces of ground screenings.
7841	Banner Milling Co., Buffalo, N. Y. "Banner Standard Midds"	Syracuse	G 15. F 16.9	4.25 5.6	9.75 6.5	Wheat middlings with ground screenings not exceeding mill run. Wheat middlings containing traces of ground screenings.
7984	Bay State Milling Co., Winona, Minn. "Red Dog Flour"	Canisteo	G 18. F 17.8	4.05 4.9	2.5 2.3	Wheat white middlings.
8723	Bay State Milling Co., Winona, Minn. "Winona Wheat Middlings with Ground Screenings from Wheat not Exceeding Mill Run"	Jamestown	G 17. F 16.9	5. 5.3	8. 7.	Screenings less than eight per ct. Wheat middlings, ground screenings.

0190	Bay State Milling Co., Winona, Minn. "Winona Fancy White Flour Middlings"	Ballston Lake	G F	18. 17.6	4.5 4.6	3. 2.	Wheat white middlings.
7872	Big Diamond Mills Co., Minneapolis, Minn. "Big Diamond Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	Sheds Corners	G F	14.67 18.0	4.21 5.5	9.35 6.8	Wheat middlings, ground screenings.
7564	Big Diamond Mills Co., Minneapolis, Minn. "Big Diamond Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	Port Chester	G F	14.67 18.	4.21 5.1	9.35 5.4	Wheat product. Wheat middlings, ground screenings.
7375	Bill, Bell & Co., Ogdensburg, N. Y. "Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run"	Ogdensburg	G F	16.5 18.9	5. 4.3	4. 2.	Ground screenings not exceeding mill run. Wheat middlings, containing traces of ground screenings.
7376	Bill, Bell & Co., Ogdensburg, N. Y. "Wheat Shorts with Ground Screenings not Exceeding Mill Run"	Ogdensburg	G F	16. 18.4	5. 5.1	10. 3.8	Ground screenings not exceeding mill run. Wheat middlings containing traces of ground screenings.
8608	The Birkett Mills, Penn Yan, N. Y. "Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Genoa	G F	15.75 14.1	4. 4.6	5.5 3.2	Wheat middlings containing traces of ground screenings.
0100	Blaine, Mackay, Lee Co., North East, Pa. "Pure Wheat Middlings with Mill Run Screenings"	Fredonia	G F	16. 15.8	4. 5.1	6. 4.2	Wheat middlings, ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*)

Number	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT MIDDLINGS (*continued*).		*Per ct.*	*Per ct.*	*Per ct.*	
0379	Buffalo Cereal Co., Buffalo, N. Y. "Flour Middlings with not to Exceed Mill Run of Ground Screenings"	Middletown	G* 16. F* 16.1	4.5 5.9	8. 4.9	Wheat middlings, ground screenings.
8559	J. P. Burroughs & Son, Flint, Mich. "Fancy Winter Middlings"	Whitney Point	G — F 14.6	— 4.3	— 2.7	With ground screenings not exceeding mill run. Wheat middlings containing a trace of ground screenings.
071	Cataract City Milling Co., Niagara Falls, N. Y. "White Middlings with Ground Screenings not Exceeding Mill Run"	Niagara Falls	G 14. F 16.4	5. 5.5	10. 4.9	Wheat middlings, ground screenings.
8170	Cataract City Milling Co., Niagara Falls, N. Y. "Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	Beacon	G 15.57 F 16.3	5.45 5.2	— 8.1	Wheat product. Wheat middlings, ground screenings.
8178	C. S. Christensen Co., Madelia, Minn. "Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run"	Stormville	G 14.25 F 17.1	3. 5.1	5.35 4.4	Wheat middlings and ground screenings not exceeding mill run. Wheat middlings, ground screenings.
065	L. Christian & Co., Minneapolis, Minn. "Matchless Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	Akron	G 15.5 F 15.2	4.65 4.5	8.4 6.6	Wheat middlings, ground screenings.

8737	Claro Milling Co., Waseca, Minn. "Claro Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	Wellsville	G	14.	3.	12.	
			F	16.4	5.9	6.6	Wheat middlings, ground screenings.
0384	The Cleveland Milling Co., Cleveland, O. "Special Fine Middlings"	Kingston	G	15.	5.	6.	Made from wheat with ground screenings not exceeding mill run.
			F	14.9	4.4	2.6	Wheat middlings, ground screenings.
0561	The Cleveland Milling Co., Cleveland, O. "Special Fine Middlings with Ground Screenings not Exceeding Mill Run"	Brocton	G	15.	5.	6.	
			F	15.3	5.4	4.1	Wheat middlings, ground screenings.
0156	The Cleveland Milling Co., Cleveland, O. "Wheat Coarse Middlings with Ground Screenings not Exceeding Mill Run"	Catskill	G	14.	4.5	9.	
			F	16. 1	5.5	7.1	Wheat middlings, ground screenings.
8426	The Cleveland Milling Co., Cleveland, O. "Wheat Coarse Middlings with Ground Screenings not Exceeding Mill Run"	Elmira	G	14.	4.5	9.	
			F	16.1	5.4	6.9	Wheat middlings, ground screenings.
0154	The Cleveland Milling Co., Cleveland, O. "Wheat Fine Middlings with Ground Screenings not Exceeding Mill Run"	Catskill	G	15.	3.5	6.	
			F	16.1	4.9	5.7	Wheat middlings, ground screenings.
8420	The Cleveland Milling Co., Cleveland, O. "Wheat Fine Middlings with Ground Screenings not Exceeding Mill Run"	Elmira	G	15.	3.5	6.	
			F	16.1	4.7	4.1	Wheat middlings, ground screenings.
8334	Commander Mill Co., Minneapolis, Minn. "Battleship Low Grade"	Rome	G	18.	4.5	4.	
			F	15.7	4.2	1.3	Wheat white middlings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT MIDDLINGS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
0192	The Commercial Milling Co., Detroit, Mich. " Standard Wheat Middlings with Ground Screenings not Exceeding Mill Run "	Albany	G* 13.5 F* 16.1	4.5 5.5	10. 8.7	Wheat middlings, ground screenings.
8315	Crookston Milling Co., Crookston, Minn. " Fine Middlings "	New Bremen	G 15.3 F 16.3	5.3 4.9	7. 5.6	Fine middlings with ground screenings not exceeding mill run. Wheat middlings containing traces of ground screenings.
8181	Crystal Milling Co., Lake Crystal, Minn. " Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run "	Brewster	G 14.25 F 16.1	3. 4.1	5.35 4.1	Wheat flour middlings. Wheat middlings, ground screenings.
8869	J. G. Davis Co., Rochester, N. Y. " Wheat Middlings, Granite Brand "	Schoharie	G 15. F 17.1	4.5 5.8	10.5 4.6	Wheat middlings containing a small amount of ground screenings.
7948	Duluth-Superior Milling Co., Duluth, Minn. " Standard S Middlings, Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run "	Addison	G 16.5 F 16.2	4.75 5.3	7.75 6.5	Wheat middlings containing traces of ground screenings.
8040	Eagle Roller Mills Co., New Ulm, Minn. " Wheat Middlings with Ground Screenings not Exceeding Mill Run "	Valley Stream	G 15.45 F 16.6	4.53 4.9	9.5 7.8	Wheat middlings.

8405	Everett Augenbaugh & Co., Waseca, Minn. "E-A-Co. Wheat Middlings"	Port Byron	G	15.	3	10.	Standard and flour middlings and ground screenings not exceeding mill run.
			F	16.1	5.7	6.9	Wheat middlings, ground screenings.
010	Empire Grain & Elevator Co., Binghamton, N. Y. "Pillsbury X X Daisy"	Sidney	G	17.	4.5	4.	A pure wheat product.
			F	16.5	4.9	2.3	Wheat white middlings.
09	Empire Grain & Elevator Co., Binghamton, N. Y. "Russell Miller Milling Co. Standard Middlings"	Sidney	G	15.	4.	9.	Made from wheat only.
			F	16.5	5.4	7.8	Wheat middlings containing traces of ground screenings.
012	The Farmers Co-operative Co., Defiance, O. "Middlings"	Sidney	G	——	——	——	
			F	14.1	3.6	2.6	Wheat middlings.
7874	Federal Milling Co., Lockport, N. Y. "Dairy Maid Winter Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Camillus	G	16.	5.	7.	
			F	16.	5.2	4.3	Wheat middlings, ground screenings.
6378	Federal Milling Co., Lockport, N. Y. "Lucky Spring Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run"	Batavia	G	17.	5.	8.	
			F	17.9	5.8	5.8	Wheat middlings, ground screenings.
9003	Federal Milling Co., Lockport, N. Y. "Sphinx Fancy Spring Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run"	Amsterdam	G	17.	4.5	9.	
			F	16.9	4.7	4.7	Wheat middlings, ground screenings.
8306	James Frazee Milling Co., Baldwinsville, N. Y. "Frazee's Fancy White Middlings"	Oswego	G	——	——	——	
			F	14.3	4.	2.9	Wheat middlings, ground screenings.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT MIDDLINGS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
7946	The Gardner Mills, Hastings, Minn. "Snowball Wheat White Middlings with Ground Screenings not Exceeding Mill Run"	Canisteo	G* 15. F* 16.	4. 4.9	7.5 4.7	Wheat middlings containing traces of ground screenings
8626	The Gardner Mills, Hastings, Minn. "Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	Syracuse	G 15.9 F 15.7	4.5 6.4	10. 7.9	Wheat middlings, ground screenings
0198	The Gardner Mills, Hastings, Minn. "Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	Watervliet	G 15.9 F 17.7	4.5 6.	10. 8.	Wheat middlings, ground screenings
8621	General Flour & Feed Co., Buffalo, N. Y. "O. K. Flour Middlings"	Syracuse	G 15. F 14.8	4. 4.7	10. 9.4	Made from wheat only with ground screenings not exceeding mill run. Wheat middlings, ground screenings.
8629	Great Northern Flour Mills Co., St. Cloud, Minn. "Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	Syracuse	G 15. F 14.9	5. 6.1	9.5 7.	Wheat middlings containing a trace of screenings.
7881	Peter Greiner Co., East Syracuse, N. Y. "Mayflower Middlings"	Minoa	G 14. F 16.1	4 4.9	9. 7 1	Pure wheat product with ground screenings not exceeding mill run. Wheat middlings containing traces of ground screenings.

6797	The Harter Milling Co., Toledo, O. "Harter's Winter Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Locke	G 15. F 15.2	4. 4.5	6.5 4.8	Winter wheat middlings with ground screenings not exceeding mill run Wheat middlings, ground screenings
7995	Hecker-Jones-Jewell Milling Co., Buffalo, N. Y. "Flour Middlings with Mill Run Screenings"	Holcomb	G 16. F 18.4	5.5 5.4	8. 8.7	Made from wheat. Wheat middlings containing traces of ground screenings.
0191	Hecker-Jones-Jewell Milling Co., Buffalo, N. Y. "Red Dog"	Ballston Spa	G 16.75 F 17.1	5. 4.5	5.25 2.1	Made from wheat. Wheat white middlings.
9008	Hecker-Jones-Jewell Milling Co., Buffalo, N. Y. "Standard Middlings with Mill Run Screenings"	Johnstown	G 16.5 F 17.5	6. 5.9	8.5 8.5	Middlings with mill run screenings Wheat middlings, ground screenings
0200	J. A. Hinds & Co., Rochester, N. Y. "Wheat Middlings"	Schenectady	G 17.5 F 18.8	5.3 6.4	7.5 5.2	 Wheat middlings.
7989	J. A. Hinds & Co., Rochester, N. Y. "Wheat Middlings"	E. Williamson	G 12.5 F 18.8	5.3 5.8	7.5 5.	 Wheat middlings containing traces of ground screenings
8857	Hubbard Milling Co., Mankato, Minn. "Standard Fine Middlings with Ground Screenings not Exceeding Mill Run"	Schoharie	G 14.5 F 18.2	5.1 5.4	10. 7.2	 Wheat middlings, ground screenings.
8179	Hubbard Milling Co., Mankato, Minn. "Wheat Standard Fine Middlings with Ground Screenings not Exceeding Mill Run"	Stormville	G 18.7 F 18.1	4.59 6.	9. 6.2	Wheat middlings with ground screenings not exceeding mill run. Wheat middlings, ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT MIDDLINGS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
7949	W. J. Jennison Co., Minneapolis, Minn. "Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run"	Canaseraga	G* 17. F* 18.	4.5 4.9	5.5 4.1	Wheat middlings, ground screenings.
7940	Kehlor Flour Mills Co., St. Louis, Mo. "Illmo Middlings"	Hornell	G 17. F 18.6	4. 3.4	4. 3.7	Flour, wheat middlings and ground screenings not to exceed mill run. Wheat middlings containing traces of ground screenings.
7907	Kehlor Flour Mills Co., St. Louis, Mo. "Rex Middlings with Ground Screenings not Exceeding Mill Run"	Warsaw	G 16. F 18.2	4. 4.2	7. 5.4	Wheat middlings, ground screenings.
011	Kemper Mill & Elevator Co., Kansas City, Mo. "Carnation Gray Middlings"	Walton	G 16. F 18.2	4.3 4.8	8. 4.5	Made from pure wheat. Wheat middlings
8607	Kemper Mill & Elevator Co., Kansas City, Mo. "Crescent Middlings with Ground Screenings not Exceeding Mill Run"	Newburgh	G 16. F 16.5	4. 4.6	8. 6.8	Wheat middlings, ground screenings.
0183	Keusch & Schwartz Co., Inc., New York, N. Y. "K & S Wheat Middlings and Mill Run Screenings"	Weedsport	G 15. F 16.5	5. 3.6	9.5 8.3	Wheat and mill run screenings. Wheat middlings, ground screenings.

7938	King Milling Co., Lowell, Mich. "Kimco Middlings, Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Hornell	G F	13.5 13.7	3 4.2	7. 4.6	Wheat middlings.
0385	La Grange Mills, Red Wing, Minn. "Wheat Fine Middlings with Ground Screenings not Exceeding Mill Run"	Kingston	G F	15.5 17.1	5. 5.9	9.5 6.2	Wheat middlings, ground screenings.
8028	The Larabee Flour Mills Co., Hutchinson, Kans. "Wheat Shorts with Mill Run of Screenings not to Exceed eight per ct."	Hempstead	G F	17. 19.7	4. 5.4	5. 4.	Wheat middlings, containing a trace of ground screenings.
0595	Listman Mill Co., La Crosse, Wis. "Elmco Wheat Standard Middlings and Screenings"	Friendship	G F	18.18 16.3	5.57 6.2	10.02 6.4	Wheat middlings, ground screenings.
8262	The Lyons Milling Co., Lyons, Kans. "Wheat White Shorts"	Oneonta	G F	15. 17.9	4. 3.1	3.5 3.6	Wheat middlings.
8289	Maple Leaf Milling Co., Ltd., Toronto, Canada "Fancy Canadian Middlings"	Williamstown	G F	16. 17.9	5.5 5.6	10. 7.1	With ground screenings not exceeding mill run. Wheat middlings, ground screenings.
6637	Maple Leaf Milling Co., Ltd., Toronto, Canada "Fancy Canadian Middlings with Ground Screenings not Exceeding Mill Run"	Whitehall	G F	16. 17.7	5.5 6.1	10. 6.5	Wheat middlings, ground screenings.
8553	Mayflower Mills, Fort Wayne, Ind. "Mayflower Middlings"	Oxford	G F	14. 15.4	4. 5.1	9. 5.9	Pure wheat product with ground screenings not exceeding mill run. Wheat middlings, ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT MIDDLINGS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
8267	Geo. Q. Moon & Co., Binghamton, N. Y. "Fresh Ground Middlings"	Richfield Spgs.	G* 17.5	5.3	7.5	
			F* 14.7	4.5	4.9	Wheat middlings containing traces of ground screenings. Approximately 1.4 per ct. of ground corn and oats present.
8134	Moseley & Motley Milling Co., Rochester, N. Y. "Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Poughkeepsie	G 15.	4.5	10.	Wheat product.
			F 19.2	6.	6.3	Wheat middlings, ground screenings.
8027	National Feed Co., St. Louis, Mo. "Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Hempstead	G 16.	4.	9.	Wheat middlings and ground screenings only.
			F 18.	5.3	4.7	Wheat middlings, containing traces of ground screenings.
8233	New Prague Flouring Mill Co., New Prague, Minn. "Seal of Minnesota Fancy Flour Middlings"	Whitesboro	G 17.	5.5	5.	
			F 16.6	4.8	3.6	Wheat middlings, containing traces of ground screenings.
8234	New Prague Flouring Mill Co., New Prague, Minn. "Seal of Minnesota Standard Middlings"	Whitesboro	G 17.75	5 5	6.75	Standard middlings with ground screenings not exceeding mill run.
			F 17.6	5.4	4.8	Wheat middlings containing traces of ground screenings.
8202	The Northwestern Consolidated Mlg. Co., Minneapolis, Minn. "Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run"	Mohawk	G 15.5	4.5	6.	
			F 16.1	4.1	5.5	Wheat middlings, ground screenings.

8136	The Northwestern Consolidated Mlg. Co., Minneapolis Minn. " Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run "	Poughkeepsie	G F	15. 17.3	4.5 6.	11. 8.1	Wheat product. Wheat middlings, ground screenings.
8447	Ontario Roller Mills, Fenton & Hawkins, Canandaigua, N. Y. " Wheat Middlings "	Canandaigua	G F	—— 15.3	—— 5.	—— 5.4	Wheat middlings.
8313	Osakis Milling Co., Osakis, Minn. " Middlings "	New Bremen	G F	16. 17.7	4. 6.1	14. 5.9	Wheat middlings containing traces of ground screenings.
8281	Pelican River Mill Co., Elizabeth, Minn. " Middlings "	Rome	G F	15.85 16.	4.4 5.8	—— 7.2	Wheat middlings containing traces of ground screenings.
8751	Phelps & Sibley Co., Cuba, N. Y. " Phelps & Sibley Co's Fancy Wheat Middlings with Ground Screenings not Exceeding Mill Run "	Cuba	G F	15. 15.2	4. 4.8	8. 4.7	Wheat middlings, ground screenings.
064	Philip Houck Milling Co., Buffalo, N. Y. " Wheat Middlings with Ground Screenings not Exceeding Mill Run "	Clarence	G F	—— 15.3	—— 6.2	—— 5.6	Wheat middlings, ground screenings.
7936	Pillsbury Mills, Minneapolis, Minn. " Pillsbury's Wheat A Middlings with Ground Screenings not Exceeding Mill Run "	Hornell	G F	15. 16.8	4.5 4.6	7. 5.1	Standard B middlings and low grade flour with ground screenings not exceeding mill run. Wheat middlings, low grade wheat flour, traces of ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT MIDDLINGS (*continued*)		*Per ct.*	*Per ct.*	*Per ct.*	
7937	Pillsbury Mills, Minneapolis, Minn. "Pillsbury's Wheat Standard B Middlings with Ground Screenings not Exceeding Mill Run"	Hornell	G* 15. F* 14.7	4.5 5.6	10. 9.4	Wheat middlings, ground screenings.
8261	Pillsbury Flour Mills Co., Minneapolis, Minn. "Pillsbury's XX Daisy"	Oneonta	G 17. F 18.4	4.5 5.	4. 3.4	A pure wheat product. Wheat middlings.
8330	H. Prange & Son, New Douglas, Ill. "Prange's Midds"	Lowville	G 15. F 17.2	3.5 4.4	6. 3.3	Wheat middlings containing a trace of ground screenings.
8290	Red Wing Milling Co., Red Wing, Minn. "Bixota Wheat Middlings"	Williamstown	G 18.3 F 18.0	5.7 5.7	7.5 7.	Wheat middlings containing traces of ground screenings.
8293	Red Wing Milling Co., Red Wing, Minn. "Bixota Flour Middlings"	Williamstown	G 18. F 17.9	5. 4.7	4.9 3.3	Flour middlings. Wheat middlings containing traces of ground screenings.
8272	Russell Miller Milling Co., Minneapolis, Minn. "Flour Middlings"	Bridgewater	G 16. F 16.4	5. 3.8	6. 3.	Made from wheat only. Wheat middlings.
7955	Schultz, Banjan & Co., Beardstown, Ill. "Sunbeam Pure Soft Winter Wheat Middlings with Mill Run Screenings"	Caledonia	G 15. F 14.9	3.5 4.6	10. 8.	Wheat middlings, ground screenings.

7897	Shane Bros. & Wilson Co., Arlington, S. D. " Arlington Wheat White Middlings with Ground Screenings not Exceeding Mill Run "	Syracuse	G F	15. 15.8	4. 4.7	7.5 6.	Wheat middlings containing a small amount of ground screenings.
8264	Shane Bros. & Wilson Co., Hastings, Minn. " Snowball Wheat White Middlings with Ground Screenings not Exceeding Mill Run "	Wells Bridge	G F	15. 17.9	4. 5.	7.5 4.1	Wheat white middlings with ground screenings not exceeding mill run. Wheat middlings, ground screenings.
0577	Shane Bros. & Wilscn Co., Arlington, S. D. " Wheat Standard Middlings with Ground Screenings not Exceeding Mill Mill Run "	Olean	G F	15.9 15.6	4.5 5.3	10. 7.	Wheat middlings, ground screenings.
7568	Sheffield King Milling Co., Minneapolis, Minn. " Fairybow "	Mount Kisco	G F	17.15 16.5	5.01 4.6	8.96 6.1	Standard middlings, wheat product and pulverized wheat screenings. Wheat middlings, ground screenings.
7587	Sleepy Eye Flour Mills, Minneapolis, Minn. " Standard Middlings with not to Exceed Mill Run of Ground Screenings "	Hudson	G F	16.5 16.6	4.5 4.9	9.5 6.2	Wheat middlings, ground screenings.
0597	Standard-Tilton Milling Co., St. Louis, Mo. " Wheat Middlings with Screenings not Exceeding Mill Run "	Cuba	G F	15. 16.6	4. 5.1	6. 4.3	Wheat middlings containing a trace of ground screenings.
8868	Standard-Tilton Milling Co., St. Louis, Mo. " Wheat Middlings with Screenings not Exceeding Mill Run "	Schoharie	G F	15. 18.8	4. 4.9	6. 4.7	Wheat middlings containing a small amount of ground screenings.
8217	F. W. Stock & Sons, Hillsdale, Mich. " Middlings "	Boonville	G F	16.5 16.3	4. 4.4	6. 5.1	Made from pure wheat. Wheat middlings containing traces of ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT MIDDLINGS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
8285	David Stott Flour Mills, Detroit, Mich. "Climax Middlings"	Rome	G* 17.	5.	8.	
			F* 16.6	4.7	5.4	Wheat middlings containing traces of ground screenings.
8286	David Stott Flour Mills, Detroit, Mich. "Fine White Middlings"	Camden	G 16.	5.	6.	
			F 16.	4.3	4.4	Wheat middlings containing traces of ground screenings.
8550	Tioga Mill & Elevator Co., Waverly, N. Y. "Waverly Flour Wheat Middlings"	Conklin	G 15.	4.	6.	May contain ground screenings not exceeding mill run.
			F 16.7	5.	6.7	Wheat middlings, ground screenings.
8229	Thompson Milling Co., Lockport, N. Y. "Angelus Flour Middlings with Ground Screenings not Exceeding Mill Run"	Stittville	G 13.	4.	13.	
			F 17.	3.6	5.2	Wheat middlings containing a trace of ground screenings.
6372	Thompson Milling Co., Lockport, N. Y. "Angelus Middlings with Ground Screenings not Exceeding Mill Run"	Batavia	G 13.	4.	13.	
			F 16.9	5.6	7.	Wheat middlings, ground screenings.
7050	Thornton & Chester Milling Co., Buffalo, N. Y. "T. & C. Wheat Coarse Midds with Ground Screenings not Exceeding Mill Run"	Ithaca	G 15.	4.	8.	
			F 17.5	5.2	7.9	Wheat middlings, containing traces of ground screenings.
7851	Thornton & Chester Milling Co., Buffalo, N. Y. "T. & C. Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Ithaca	G 15.	4.	6.5	
			F 17.	5.5	5.9	Wheat middlings containing traces of ground screenings.

8813	Traders & Producers Supply Co., Buffalo, N. Y. "Chippewa Fancy Middlings with Ground Screenings not Exceeding Mill Run"	Fort Edward	G	16.	5.5	16.	
			F	16.9	4.6	6.6	Wheat middlings, ground screenings.
6389	George Urban Milling Co., Buffalo, N. Y. "Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Attica	G	16.	4.5	9.5	
			F	15.9	5.8	9.4	Wheat middlings, ground screenings.
8249	Valley City Milling Co., Grand Rapids, Mich. "Farmers Favorite Middlings"	Oneonta	G	15.5	4.25	7.	Choice wheat standard middlings with ground screenings not exceeding mill run.
			F	17.1	4.6	4.2	Wheat middlings containing traces of ground screenings.
9005	Victor Milling Co., Victor, N. Y. "Victor Spring Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Gloversville	G	17.5	5.	10.	Middlings with ground screenings not exceeding mill run.
			F	17.4	6.2	6.7	Wheat middlings, ground screenings.
8154	Washburn Crosby Co., Minneapolis, Minn. "Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run"	Clinton Corners	G	17.	5.	6.5	Wheat product.
			F	17.4	5.2	5.5	Wheat middlings, ground screenings.
8125	Washburn Crosby Co., Minneapolis, Minn. "Wheat Standard Middlings with Ground Screenings not Exceeding Mill Run"	Poughkeepsie	G	15.	5.	9.5	Wheat product.
			F	17.3	5.4	6.2	Wheat middlings, ground screenings.
7867	Western Canada Flour Mills Co., Ltd. Toronto, Canada "Spring Wheat Middlings with Ground Screenings not Exceeding Mill Run"	Tully	G	16.	5.	8.	
			F	19.1	5.5	5.4	Wheat middlings, ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT MIDDLINGS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*	
8748	Western Canada Flour Mills Co., Ltd., Toronto, Canada "Wheat Flour Middlings with Ground Screenings not Exceeding Mill Run"	Olean	G* 16.5 F* 14.3	5. 4.3	4.8 4.	Wheat middlings, ground screenings.
	WHEAT BRAN, WHEAT MIDDLINGS:					
7862	Ames Burns Co., Jamestown, N. Y. "Perfection Fancy Winter Bran with Ground Screenings not Exceeding Mill Run"	Marathon	G 14. F 16.3	3. 4.6	10. 6.7	Pure winter wheat product with ground screenings not exceeding mill run. Wheat bran, wheat middlings, ground screenings.
6394	Banner Milling Co., Buffalo, N. Y. "Banner Bran, Wheat Bran with Ground Screenings not Exceeding Mill Run"	Darien Center	G 15. F 17.3	4.25 5.5	9.75 8.3	Wheat bran, wheat middlings, ground screenings.
7900	Banner Milling Co., Buffalo, N. Y. "Banner Mixed Feed (from Wheat Only)"	DeRuyter	G 15. F 16.9	4.25 5.1	9.75 8.6	Wheat mixed feed with ground screenings not exceeding mill run. Wheat bran, wheat middlings and a small amount of ground screenings.
0172	M. F. Baringer, Philadelphia, Pa. "Keystone Fancy Mixed Feed"	Goshen	G 15.4 F 16.	4.5 4.8	9.3 7.1	Wheat bran, wheat middlings and a small amount of ground screenings.
8724	Bay State Milling Co., Winona, Minn. "Winona Fancy Mixed Wheat Feed"	Jamestown	G 17. F 16.8	5. 4.9	10. 6.	Wheat bran, middlings and red dog flour with ground screenings from wheat, screenings less than 6 per ct. Wheat bran, wheat middlings, ground screenings.

8253	Morris Bros., Oneonta, N. Y. "Delaware Feed"	Oneonta	G	16.	3.75	8.5	
			F	16.1	4.9	7.7	Wheat bran, wheat middlings and traces of ground screenings.
9018	National Milling Co., Toledo, O. "National Feed"	Pine Island	G	16.	3.75	8.5	Made from pure bran and middlings.
			F	16.1	4.8	7.6	Wheat bran, wheat middlings, traces of ground screenings.
7865	National Milling Co., Toledo, O. "National Feed"	Apulia Station	G	16.	3.75	8.5	
			F	16.8	5.	6.7	Wheat bran, wheat middlings, traces of ground screenings.
096	National Milling Co., Toledo, O. "Osota Feed"	Dunkirk	G	17.	4.5	8.	
			F	15.5	5.8	7.8	Wheat bran, wheat middlings, ground screenings.
7081	National Milling Co., Toledo, O. "Osota Mixed Feed"	Walton	G	17.	4.5	8.	
			F	16.9	4.7	7.2	Wheat bran, wheat middlings, ground screenings.
7869	National Milling Co., Toledo, O. "Pennant Feed"	East Homer	G	16.	3.75	8.5	
			F	15.2	4.7	5.9	Wheat bran, wheat middlings, traces of ground screenings.
8252	The National Milling Co., Toledo, O. "Pennant Highest Quality Feed"	Oneonta	G	16.	3.75	8.5	
			F	16.4	4.9	6.4	Wheat bran, wheat middlings and traces of ground screenings.
7028	Noblesville Milling Co., Noblesville, Ind. "N. M. Co's Mixed Feed"	Cortland	G	16.	4.	8.	Pure wheat feed, wheat bran, middlings and ground wheat screenings not exceeding mill run.
			F	17.8	6.	6.1	Wheat bran, wheat middlings, traces of ground screenings.
8230	The Northwestern Consolidated Mlg. Co., Minneapolis, Minn. "Wheat Mixed Feed"	Holland Patent	G	15.	4.5	10.	Wheat bran, flour middlings and ground screenings not exceeding mill run.
			F	16.2	4.9	7.	Wheat bran, wheat middlings, ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BRAN, WHEAT MIDDLINGS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
7799	Federal Milling Co., Lockport, N. Y. "Lucky Spring Wheat Mixed Feed with Ground Screenings not Exceeding Mill Run"	Herkimer	G* 15. F* 16.6	4. 5.3	10. 8.8	Wheat bran, wheat middlings, ground screenings.
8307	James Frazee Milling Co., Baldwinsville, N. Y. "Frazee's Fancy Mixed Feed"	Oswego	G — F 14.	— 3.7	— 4.3	Bran and middlings. Wheat bran, wheat middlings, ground screenings.
8291	Glen Ullin Roller Mills, Glen Ullin, N. D. "Bran & Shorts"	Williamstown	G 16. F 15.6	4.5 5.2	8. 8.2	Wheat bran, wheat middlings, ground screenings.
7887	The Harter Milling Co., Toledo, O. "Harter's Spring Wheat Mixed Feed with Ground Screenings not Exceeding Mill Run"	Marathon	G 15. F 16.	4. 5.3	8. 7.8	Wheat bran, wheat middlings, traces of ground screenings.
7888	The Harter Milling Co., Toledo, O. "Harter's Winter Wheat Mixed Feed with Ground Screenings not Exceeding Mill Run"	Marathon	G 15. F 16.1	4. 4.9	8. 7.2	Wheat bran, wheat middlings, traces of ground screenings.
8220	The Harter Milling Co., Toledo, O. "Harter's Winter Wheat Mixed Feed with Ground Screenings not Exceeding Mill Run"	Boonville	G 15. F 15.8	4. 4.4	8. 6.4	Wheat bran, wheat middlings, traces of ground screenings.

	[illegible] & Sons, Hillsdale, Mich. "Monarch Fancy Wheat Feed"	Lowville	G F	16. 15.6	4. 5.5	10. 6.4	With mill run screenings. Wheat bran, wheat middlings, ground screenings.
8616	David Stott Flour Mills, Inc., Detroit, Mich. "Stott's Honest Mixed Feed, Pure Winter Wheat"	Moravia	G F	16.5 15.4	5. 5.7	8. 7.4	Wheat bran and middlings. Wheat bran, wheat middlings, ground screenings.
8128	Thompson Milling Co., Lockport, N. Y. "Angelus Mixed Feed with Ground Screenings not Exceeding Mill Run"	Poughkeepsie	G F	15. 16.8	4. 4.8	13. 7.3	Wheat feed. Wheat bran, wheat middlings, ground screenings.
9014	Thompson & Mould, Goshen, N. Y. "Mixed Feed"	Chester	G F	14. 16.6	3.5 5.	7.5 7.1	Wheat bran, wheat middlings, wheat screenings, corn bran. Wheat bran, wheat middlings, ground screenings, traces of corn bran.
7049	Thorton & Chester Milling Co., Buffalo, N. Y. "T. & C. Wheat Bran with Ground Screenings not Exceeding Mill Run"	Ithaca	G F	14.5 14.6	4. 5.	11. 8.7	Wheat bran, wheat middlings, ground screenings.
8214	Thornton & Chester Milling Co., Buffalo, N. Y. "T. & C. Wheat Mixed Feed with Ground Screenings not Exceeding Mill Run"	Boonville	G F	15. 16.5	4.5 5.3	9. 8.7	Wheat bran, wheat middlings, ground screenings.
086	George Urban Milling Co., Buffalo, N. Y. "Wheat Superior Mixed Feed"	Buffalo	G F	16. 16.	4. 6.	10.5 8.2	Wheat bran, flour middlings and ground screenings not exceeding mill run. Wheat bran, wheat middlings, ground screenings.
8266	Valley City Milling Co., Grand Rapids, Mich. "Farmers' Favorite Choice Wheat Cow Feed"	Richfield Spgs.	G F	14.18 15.2	4.25 4.5	7.5 6.6	Choice wheat. Wheat bran, wheat middlings, traces of cockle bran.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BRAN, WHEAT MIDDLINGS (*continued*):		*Per ct.*	*Per ct.*	*Per ct.*	
8239	Lawrenceburg Roller Mills Co., Lawrenceburg, Ind.	Worcester	G* 15.2	4.3	8.	Wheat product with ground screenings not exceeding mill run.
	" Snowflake Mixed Feed "		F* 16.8	5.	8.1	Wheat bran, wheat middlings, traces of ground screenings.
7584	Lawrenceburg Roller Mills Co., Lawrenceburg, Ind.	Philmont	G 15.2	4.3	8.	Wheat product and screenings.
	" Snowflake Mixed Feed "		F 16.1	4.3	7.2	Wheat bran, wheat middlings, screenings.
098	Maple Leaf Milling Co., Ltd. Toronto, Canada.	Fredonia	G 17.	6.	9.5	Bran and middlings, not exceeding mill run of screenings.
	" Maple Leaf Choice Mixed Feed "		F 16.3	6.2	8.6	Wheat bran, wheat middlings and a small amount of ground screenings.
7379	Mayflower Mills, Ft. Wayne, Ind.	Massena	G 14.	4.	9.	Pure wheat product with ground screenings not exceeding mill run.
	" Waumbeck Mixed Feed "		F 16.6	4.6	4.8	Wheat bran, wheat middlings, small amounts of ground screenings and cockle bran.
7097	Geo. Q. Moon & Co., Binghamton, N. Y.	Liberty	G 16.	5.	8.	Wheat mixed feed with ground grain screenings not exceeding mill run.
	" Fresh Ground Mixed Feed "		F 15.9	4.3	6.5	Wheat bran, wheat middlings, ground screenings.
7040	Geo. Q. Moon & Co., Binghamton, N. Y.	Little York	G 16.5	5.09	7.	Wheat mixed feed with ground screenings not exceeding mill run.
	" Fresh Ground Mixed Feed "		F 16.1	4.6	7.1	Wheat bran, wheat middlings, ground screenings.

8253	Morris Bros., Oneonta, N. Y. "Delaware Feed"	Oneonta	G 16. F 16.1	3.75 4.9	8.5 7.7	Wheat bran, wheat middlings and traces of ground screenings.
9018	National Milling Co., Toledo, O. "National Feed"	Pine Island	G 16. F 16.1	3.75 4.8	8.5 7.6	Made from pure bran and middlings. Wheat bran, wheat middlings, traces of ground screenings.
7865	National Milling Co., Toledo, O. "National Feed"	Apulia Station	G 16. F 16.8	3.75 5.	8.5 6.7	Wheat bran, wheat middlings, traces of ground screenings.
096	National Milling Co., Toledo, O. "Osota Feed"	Dunkirk	G 17. F 15.5	4.5 5.8	8. 7.8	Wheat bran, wheat middlings, ground screenings.
7081	National Milling Co., Toledo, O. "Osota Mixed Feed"	Walton	G 17. F 16.9	4.5 4.7	8. 7.2	Wheat bran, wheat middlings, ground screenings.
7869	National Milling Co., Toledo, O. "Pennant Feed"	East Homer	G 16. F 15.2	3.75 4.7	8.5 5.9	Wheat bran, wheat middlings, traces of ground screenings.
8252	The National Milling Co., Toledo, O. "Pennant Highest Quality Feed"	Oneonta	G 16. F 16.4	3.75 4.9	8.5 6.4	Wheat bran, wheat middlings and traces of ground screenings.
7028	Noblesville Milling Co., Noblesville, Ind. "N. M. Co's Mixed Feed"	Cortland	G 16. F 17.8	4. 6.	8. 6.1	Pure wheat feed, wheat bran, middlings and ground wheat screenings not exceeding mill run. Wheat bran, wheat middlings, traces of ground screenings.
8230	The Northwestern Consolidated Mlg. Co., Minneapolis, Minn. "Wheat Mixed Feed"	Holland Patent	G 15. F 16.2	4.5 4.9	10. 7.	Wheat bran, flour middlings and ground screenings not exceeding mill run. Wheat bran, wheat middlings, ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	WHEAT BRAN, WHEAT MIDDLINGS (*continued*):					
7873	Rosekrans-Snyder Co., Philadelphia, Pa. "Winter Mixed Feed, Goodhart"	Oran	G* 14.5	4.	6.	Bran, middlings and mill run screenings.
			F* 16.5	5.1	7.1	Wheat bran, wheat middlings, ground screenings.
8562	Russell-Miller Milling Co., Minneapolis, Minn. "Occident Wheat Feed"	Afton	G 15.	4.5	10.	Made from wheat only.
			F 14.9	6.	7.4	Wheat bran, wheat middlings and a small amount of ground screenings.
8265	Russell-Miller Milling Co., Minneapolis, Minn. "Wheat Occident Feed"	Unadilla	G 15.	4.5	10.	Made from wheat only.
			F 16.6	5.3	5.6	Wheat bran, wheat middlings.
7598	Shane Bros. & Wilson Co., Minneapolis, Minn. "King Midas Wheat Mixed Feed with Ground Screenings not Exceeding Mill Run"	Bangall	G 14.5	4.	9.5	Wheat mixed feed with ground screenings not exceeding mill run.
			F 17.	4.7	6.9	Wheat bran, wheat middlings, a small amount of ground screenings.
8121	Sparks Milling Co., Alton, Ill. "Try Me Winter Mixed Feed"	Poughkeepsie	G 16.	3.5	8.	Pure wheat bran, middlings and ground screenings not exceeding mill run.
			F 17.	4.5	7.2	Wheat bran, wheat middlings, traces of ground screenings.
8248	F. W. Stock & Son, Hillsdale, Mich. "Bran"	Oneonta	G 14.	3.	10.	Made from pure wheat.
			F 14.2	4.6	8.7	Wheat bran, wheat middlings and traces of ground screenings.
7815	F. W. Stock & Sons, Hillsdale, Mich. "Monarch Fancy Wheat Feed"	Cortland	G 16.	4.	10.	With mill run screenings.
			F 17.3	5.2	7.3	Wheat bran, wheat middlings, ground screenings.

0752	Belmont Flouring Mills, Inc., Belmont, N. Y. "Buckwheat Feed"	Belmont	G	—	—	—	Hulls and middlings.
			F	16.7	4.3	19.2	Buckwheat middlings, buckwheat hulls.
8090	Henry Binns, East Berne, N. Y. "Buckwheat Bran"	East Berne	G	—	—	—	
			F	27.9	7.6	9.9	Buckwheat middlings, buckwheat hulls.
6398	The Birkett Mills, Penn Yan, N. Y. "Buckwheat Offal Feed"	Warsaw	G	10.	2.25	32.	Buckwheat offal and buckwheat screenings consisting of buckwheat chaff and wild seeds not exceeding mill run.
			F	14.9	3.9	28.1	Mainly buckwheat hulls, with some buckwheat bran, buckwheat middlings and screenings.
8094	Borst & Burhans, Cobleskill, N. Y. "Buckwheat Feed"	Cobleskill	G	—	—	—	
			F	31.7	8.4	7.3	Buckwheat middlings.
094	Bundy Milling Co., Angola, N. Y. "Buckwheat Middlings"	Angola	G	—	—	—	
			F	27.5	7.4	3.9	Buckwheat middlings.
8460	Fred C. Campbell, Alpine, N. Y. "Buckwheat Feed"	Alpine	G	14.	4.	27.	Contains buckwheat middlings and hulls, being entire product of grain except the flour.
			F	16.7	4.7	23.5	Buckwheat hulls, buckwheat middlings.
7384	Fred J. Clark, Champlain, N. Y. None given	Champlain	G	—	—	—	Buckwheat shucks, corn meal, coarse buckwheat flour, ground oats, wheat bran.
			F	12.5	3.3	12.2	Buckwheat middlings, buckwheat hulls, buckwheat screenings, small amounts of ground corn, oats and wheat bran.
8092	Cobleskill Milling Co., Cobleskill, N. Y. "Buckwheat Feed"	Cobleskill	G	—	—	—	
			F	26.	7.1	11.2	Buckwheat middlings, buckwheat hulls.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BRAN, WHEAT MIDDLINGS, (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*	
8612	Valley City Milling Co., Grand Rapids, Mich. "Farmers' Favorite Cow Feed"	Locke	G* 16.8	4.4	7.93	Wheat mixed feed with ground screenings not exceeding mill run.
			F* 15.7	5.	7.1	Wheat bran, wheat middlings and a small amount of ground screenings.
9015	C. W. Wagar & Co., Philadelphia, Pa. "Middlesex Winter Wheat Mixed Feed"	Chester	G 14.5	4.	10.	Composed of W. W. bran and middlings and screenings not exceeding mill run.
			F 15.8	4.5	7.1	Wheat bran, wheat middlings, ground screenings.
7863	Wagoner-Gates Milling Co., Independence, Mo. "Mill Run Bran, Mixed Feed"	Marathon	G 15.	3.	10.	Bran, middlings and shipstuff from winter wheat.
			F 17.8	5.	7.	Wheat bran, wheat middlings.
8294	The Williams Bros. Co., Kent, O. "Kent Mixed Feed"	Sandy Creek	G 12.	2.	15.	Winter wheat.
			F 14.6	4.5	6.2	Wheat bran, wheat middlings
7035	The Williams Bros. Co., Kent, O. "Kent Mixed Feed, Winter Wheat"	Groton	G 12.	2.	15.	
			F 15.4	5.5	5.5	Wheat bran, wheat middlings, traces of cockle bran.
8459	Willings Star Mills, R. J. Willing, Prop., Phelps, N. Y. "Middlings"	Phelps	G ——	——	——	
			F 14.2	4.9	4.4	Wheat bran, wheat middlings and traces of ground screenings.
8866	Yerxa, Andrews & Thurston, Minneapolis, Minn. "Durum Wheat Bran"	Central Bridge	G 12.	5.5	13.	
			F 12.7	5.4	12.6	Wheat bran, wheat middlings and a small amount of ground screenings.

0753	Not given "Spring Mixed Feed"	Belmont	G ——	——	——	Feed containing ground screenings not exceeding mill run.
			F 14.9	5.8	7.6	Wheat bran, wheat middlings, ground screenings.
	WHEAT BRAN, LOW-GRADE WHEAT FLOUR:					
7147	The Northwestern Consolidated Mlg. Co., Minneapolis, Minn. "Planet Feed"	Sidney	G 15.	4.	8.	A mixture of wheat bran and red dog.
			F 18.3	5.2	5.	Wheat bran, red dog flour.
8209	Pillsbury Flour Mills Co., Minneapolis, Minn. "Pillsbury Fancy Wheat Mixed Feed".	Boonville	G 16.	4.5	9.	Composed of wheat bran and low-grade flour, with ground screenings not exceeding mill run.
			F 16.5	4.6	7.2	Wheat bran, low-grade wheat flour, ground screenings.
	WHEAT BRAN, WHEAT MIDDLINGS, LOW-GRADE WHEAT FLOUR, GROUND SCREENINGS:					
8860	Duluth-Superior Milling Co., Duluth, Minn. "Boston Mixed Feed"	Seward	G 15.	4.25	9.75	Wheat bran, middlings, low-grade flour, with ground screenings not exceeding mill run.
			F 16.9	5.	7.7	Wheat bran, wheat middlings, low-grade wheat flour, ground screenings.
8435	Globe Elevator Co., Buffalo, N. Y. "Globe Dairy Feed"	Bath	G 14.	4.	10.	Wheat bran, wheat middlings, ground wheat screenings and low-grade flour.
			F 16.1	4.5	6.8	Wheat bran, wheat middlings, low-grade wheat flour, ground screenings.
8155	Sheffield King Milling Co., Minneapolis, Minn. "Gold Mine Feed"	Pleasant Valley	G 15.9	4.9	8.98	Bran, shorts, low grade flour, wheat product and pulverized screenings.
			F 15.9	4.8	8.2	Wheat bran, wheat middlings, low-grade wheat flour, ground screenings.
0389	F. W. Stock & Sons, Hillsdale, Mich. "Superior Wheat Feed and Flour"	Kingston	G 16.	4.5	7.	
			F 15.	4.2	5.5	Wheat bran, wheat middlings, low-grade flour, traces of ground screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BRAN, WHEAT MIDDLINGS, LOW-GRADE WHEAT FLOUR, GROUND SCREENINGS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*	
8269	F. W. Stock & Sons, Hillsdale, Mich. "Superior Wheat Feed and Flour	Hartwick	G* 16.	4.5	7.	Wheat feed and flour.
			F* 16.2	4.7	7.	Wheat bran, wheat middlings, low-grade flour and a small amount of ground screenings.
8164	Washburn Crosby Co., Minneapolis, Minn. "Wheat Mixed Feed with Ground Screenings not Exceeding Mill Run"	Beacon	G 16.	4.5	9.	Wheat bran, wheat flour middlings and ground screenings not exceeding mill run.
			F 16.4	4.	6.5	Wheat bran, wheat middlings, low-grade wheat flour, ground screenings.
	BUCKWHEAT PRODUCTS:					
0357	Robert T. Agnew, Fonda, N. Y. "Buckwheat Middlings"	Fonda	G ——	——	——	
			F 23.5	6.6	2.9	Buckwheat middlings.
0569	E. A. Bagg, Conewango Valley, N. Y. "Buckwheat Middlings"	Conewango Valley	G ——	——	——	
			F 21.8	5.8	18.7	Buckwheat middlings, buckwheat hulls.
0353	Barber & Bennett, Albany, N. Y. "Buckwheat Feed"	Albany	G 25.	4.5	15.	Buckwheat bran, midds and small portion of hulls.
			F 24.5	6.9	5.7	Buckwheat middlings.
8096	Becker & Co., Central Bridge, N. Y. "Buckwheat Feed"	Central Bridge	G ——	——	——	
			F 29.7	8.4	6.7	Buckwheat middlings.
8091	Becker Bros., Berne, N. Y. "Buckwheat Feed"	Berne	G ——	——	——	Contains mill run of buckwheat screenings.
			F 24.8	7.1	10.6	Buckwheat middlings, buckwheat hulls.

0752	Belmont Flouring Mills, Inc., Belmont, N. Y. "Buckwheat Feed"	Belmont	G	—	—	—	Hulls and middlings.
			F	16.7	4.3	19.2	Buckwheat middlings, buckwheat hulls.
8090	Henry Binns, East Berne, N. Y. "Buckwheat Bran"	East Berne	G	—	—	—	
			F	27.9	7.6	9.9	Buckwheat middlings, buckwheat hulls.
6398	The Birkett Mills, Penn Yan, N. Y. "Buckwheat Offal Feed"	Warsaw	G	10.	2.25	32.	Buckwheat offal and buckwheat screenings consisting of buckwheat chaff and wild seeds not exceeding mill run.
			F	14.9	3.9	28.1	Mainly buckwheat hulls, with some buckwheat bran, buckwheat middlings and screenings.
8094	Borst & Burhans, Cobleskill, N. Y. "Buckwheat Feed"	Cobleskill	G	—	—	—	
			F	31.7	8.4	7.3	Buckwheat middlings.
094	Bundy Milling Co., Angola, N. Y. "Buckwheat Middlings"	Angola	G	—	—	—	
			F	27.5	7.4	3.9	Buckwheat middlings.
8460	Fred C. Campbell, Alpine, N. Y. "Buckwheat Feed"	Alpine	G	14.	4.	27.	Contains buckwheat middlings and hulls, being entire product of grain except the flour.
			F	16.7	4.7	23.5	Buckwheat hulls, buckwheat middlings.
7384	Fred J. Clark, Champlain, N. Y. None given	Champlain	G	—	—	—	Buckwheat shucks, corn meal, coarse buckwheat flour, ground oats, wheat bran.
			F	12.5	3.3	12.2	Buckwheat middlings, buckwheat hulls, buckwheat screenings, small amounts of ground corn, oats and wheat bran.
8092	Cobleskill Milling Co., Cobleskill, N. Y. "Buckwheat Feed"	Cobleskill	G	—	—	—	
			F	26.	7.1	11.2	Buckwheat middlings, buckwheat hulls.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	BUCKWHEAT PRODUCTS (*concluded*):		*Per ct.*	*Per ct.*	*Per ct.*	
8609	William F. Rease & Son, Genoa, N. Y. " Buckwheat Middlings "	Genoa	G* — F* 25.2	— 6.6	— 5.9	Buckwheat middlings.
8475	Savona Milling Co., Savona, N. Y. " Buckwheat Middlings "	Savona	G — F 25.2	— 7.	— 6.2	Buckwheat middlings.
0366	Schenectady Milling Co., Schenectady, N. Y. " Buckwheat "	Schenectady	G — F 22.6	— 6.3	— 3.3	Buckwheat middlings.
0361	Wm. Servoss & Son, Amsterdam, N. Y. " Buckwheat Bran "	Amsterdam	G — F 8.4	— 1.7	— 25.3	Buckwheat hulls and buckwheat middlings.
0360	Shutts & Co., Amsterdam, N. Y. " Buckwheat Middlings "	Amsterdam	G — F 26.6	— 7.4	— 5.1	Buckwheat middlings.
8479	Chas. W. Slayton, Naples, N. Y. " Buckwheat Bran "	Naples	G — F 24.5	— 6.6	— 7.5	Buckwheat bran, buckwheat middlings and such hulls as are not removed by bolting. Buckwheat middlings, buckwheat hulls
8563	Daniel G. Stark, Waverly, N. Y. " Buckwheat Feed "	Waverly	G — F 15.6	— 4.2	— 15.3	Buckwheat middlings and buckwheat hulls. As certified.
8485	J. H. Strait Milling Co., Canisteo, N. Y. " Buckwheat Feed "	Canisteo	G — F 11.6	— 2.6	— 23.6	Buckwheat middlings and hulls. As certified.

0756	J. B. Tompkins & Son, Wellsville, N. Y. "Buckwheat Middlings"	Wellsville	G	—	—	—	
			F	20.2	5.4	8.6	Buckwheat middlings, buckwheat hulls.
0371	O. B. Vunck, Voorheesville, N. Y. "Buckwheat Feed"	Voorheesville	G	—	—	—	
			F	24.4	6.5	12.5	Buckwheat middlings, buckwheat hulls.
0370	Walpole Mills Co., Mariaville, N. Y. "Buckwheat Feed"	Mariaville	G	—	—	—	
			F	27.7	8.3	3.2	Buckwheat middlings.
6636	Daniel Washburn, Est., Gansevoort, N. Y. "Buckwheat Bran"	Gansevoort	G	—	—	—	
			F	16.5	4.4	2.7	Buckwheat product consisting principally of buckwheat middlings and buckwheat grits.
6645	W. S. Wheeler's Son, Ballston Spa, N. Y. "Buckwheat Middlings"	Ballston Spa	G	—	—	—	
			F	26.8	6.9	3.1	Buckwheat middlings.
	GROUND CORN AND OATS:						
0199	Geo. Q. Moon & Co., Binghamton, N. Y. "Old Times Horse Feed"	Saratoga	G	8.5	4.5	9.5	
			F	11.1	4.1	6.	Ground corn and oats.
8454	Rogers & Ryan, Rochester, N. Y. "Corn & Oat Chop"	Rochester	G	—	—	—	Whole corn and whole oats ground together.
			F	12.4	4.4	7.	As certified.
7394	Watertown Milling Co., Watertown, N. Y. "Garland Corn & Oats"	Watertown	G	12.	4.	11.	Corn and oats.
			F	13.9	3.9	3.1	Ground corn and oats, approximately 3.5 per ct. barley present.
	WHEAT BRAN AND CORN BY-PRODUCTS:						
7859	Empire Grain & Elevator Co., Binghamton, N. Y. "Egee Mixed Feed"	Messengerville	G	12.5	4.	9.	Maizo red dog flour and wheat bran with ground screenings not exceeding mill run.
			F	12.7	7.2	4.3	Wheat bran containing traces of ground screenings, white corn flour.

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ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.		Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	BUCKWHEAT PRODUCTS (*continued*):			*Per ct.*	*Per ct.*	*Per ct.*	
0594	The Holland Mills, Paul J. Wurst, Prop., Holland, N. Y. "Buckwheat Middlings"	Holland	G*	——	——	——	A portion of hulls with all of middlings.
			F*	18.9	5.	14.	Buckwheat middlings, buckwheat hulls.
8480	B. A. Hopkins Sons, Sodus, N. Y. "Buckwheat Feed"	Sodus	G	——	——	——	Middlings and hulls.
			F	21.2	5.9	19.	As certified.
8461	Arthur T. Kelsey, Mecklenburg, N. Y. "Buckwheat Feed"	Mecklenburg	G	15.	4.5	25.	Buckwheat middlings and buckwheat hulls being the entire product of grain after the flour is removed.
			F	16.2	4.5	21.7	Buckwheat hulls, buckwheat middlings.
0587	Lee H. Kessler, Arcade, N. Y. "Buckwheat Middlings"	Arcade	G	——	——	——	
			F	24.2	6.	3.9	Buckwheat middlings.
6638	Lapham & Parks, Glens Falls, N. Y. "Buckwheat Feed"	Glens Falls	G	——	——	——	
			F	23.3	6.1	2.4	Buckwheat middlings.
7827	The Larrowe Milling Co., Cohocton, N. Y. "Buckwheat Offal Feed"	Owego	G	10.	2.25	30.	Contains buckwheat offal and buckwheat screenings consisting of buckwheat chaff and weed seeds not exceeding mill run.
			F	10.4	3.	27.5	Buckwheat hulls, buckwheat middlings, buckwheat screenings containing a rather large amount of weed seeds.
0591	Law & Wilber, Collins, N. Y. "Buckwheat Middlings"	Collins	G	——	——	——	
			F	24.7	6.7	3.	Buckwheat middlings.

8478	J. P. Morsch & Son, Wayland, N. Y. "Buckwheat Feed"	Wayland	G	——	——	——	Buckwheat middlings and such hulls as are not removed by bolting.
			F	23.7	6.9	4.	Buckwheat middlings.
6646	Bliss Neilson, Stillwater, N. Y. "Buckwheat Feed"	Stillwater	G	——	——	——	
			F	17.7	5.2	21.4	Buckwheat hulls, buckwheat middlings.
0571	Nichols Brothers, Kennedy, N. Y. "Buckwheat Midds"	Kennedy	G	——	——	——	
			F	27.5	7.2	6.8	Buckwheat middlings.
8095	M. C. Ottman, Central Bridge, N. Y. "Buckwheat Feed"	Central Bridge	G	——	——	——	
			F	25.2	6.7	10.6	Buckwheat middlings, buckwheat hulls.
8462	George B. Patterson, Burdett, N. Y. "Buckwheat Feed"	Burdett	G	19.	4.8	22.	Buckwheat feed, the entire product of the grain after removing the flour.
			F	16.4	4.4	26.8	Buckwheat hulls, buckwheat middlings.
8565	D. V. Personius & Son, Waverly, N. Y. "Buckwheat Feed"	Waverly	G	——	——	——	Buckwheat middlings and buckwheat hulls.
			F	16.9	4.7	17.9	As certified.
0598	Phelps & Sibley Co., Cuba, N. Y. "Buckwheat Middlings"	Cuba	G	——	——	——	
			F	23.2	6.6	5.5	Buckwheat middlings, buckwheat hulls.
0600	Portville Mills, Portville, N. Y. "Buckwheat Feed"	Portville	G	——	——	——	Some hulls and the middlings.
			F	25.5	6.3	5.3	Buckwheat middlings.
6643	Edgar L. Potter, Fort Edward, N. Y. "Buckwheat Middlings"	Fort Edward	G	——	——	——	
			F	25.6	7.6	3.4	Buckwheat middlings.
6640	Finch Pruyn & Co., Inc., Glens Falls, N. Y. "Buckwheat Middlings"	Glens Falls	G	——	——	——	
			F	31.3	•8.5	3.5	Buckwheat middlings.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.		Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	BUCKWHEAT PRODUCTS (*concluded*):			*Per ct.*	*Per ct.*	*Per ct.*	
8609	William F. Rease & Son, Genoa, N. Y. "Buckwheat Middlings"	Genoa	G*	——	——	——	
			F*	25.2	6.6	5.9	Buckwheat middlings.
8475	Savona Milling Co., Savona, N. Y. "Buckwheat Middlings"	Savona	G	——	——	——	
			F	25.2	7.	6.2	Buckwheat middlings.
0366	Schenectady Milling Co., Schenectady, N. Y. "Buckwheat"	Schenectady	G	——	——	——	
			F	22.6	6.3	3.3	Buckwheat middlings.
0361	Wm. Servoss & Son, Amsterdam, N. Y. "Buckwheat Bran"	Amsterdam	G	——	——	——	
			F	8.4	1.7	25.3	Buckwheat hulls and buckwheat middlings.
0360	Shutts & Co., Amsterdam, N. Y. "Buckwheat Middlings"	Amsterdam	G	——	——	——	
			F	26.6	7.4	5.1	Buckwheat middlings.
8479	Chas. W. Slayton, Naples, N. Y. "Buckwheat Bran"	Naples	G	——	——	——	Buckwheat bran, buckwheat middlings and such hulls as are not removed by bolting.
			F	24.5	6.6	7.5	Buckwheat middlings, buckwheat hulls
8563	Daniel G. Stark, Waverly, N. Y. "Buckwheat Feed"	Waverly	G	——	——	——	Buckwheat middlings and buckwheat hulls.
			F	15.6	4.2	15.3	As certified.
8485	J. H. Strait Milling Co., Canisteo, N. Y. "Buckwheat Feed"	Canisteo	G	——	——	——	Buckwheat middlings and hulls.
			F	11.6	2.6	23.6	As certified.

0756	J. B. Tompkins & Son, Wellsville, N. Y. "Buckwheat Middlings"	Wellsville	G	——	——	——	
			F	20.2	5.4	8.6	Buckwheat middlings, buckwheat hulls.
0371	O. B. Vunck, Voorheesville, N. Y. "Buckwheat Feed"	Voorheesville	G	——	——	——	
			F	24.4	6.5	12.5	Buckwheat middlings, buckwheat hulls.
0370	Walpole Mills Co., Mariaville, N. Y. "Buckwheat Feed"	Mariaville	G	——	——	——	
			F	27.7	8.3	3.2	Buckwheat middlings.
6636	Daniel Washburn, Est., Gansevoort, N. Y. "Buckwheat Bran"	Gansevoort	G	——	——	——	
			F	16.5	4.4	2.7	Buckwheat product consisting principally of buckwheat middlings and buckwheat grits.
6645	W. S. Wheeler's Son, Ballston Spa, N. Y. "Buckwheat Middlings"	Ballston Spa	G	——	——	——	
			F	26.8	6.9	3.1	Buckwheat middlings.
	GROUND CORN AND OATS:						
0199	Geo. Q. Moon & Co., Binghamton, N. Y. "Old Times Horse Feed"	Saratoga	G	8.5	4.5	9.5	
			F	11.1	4.1	6.	Ground corn and oats.
8454	Rogers & Ryan, Rochester, N. Y. "Corn & Oat Chop"	Rochester	G	——	——	——	Whole corn and whole oats ground together.
			F	12.4	4.4	7.	As certified.
7394	Watertown Milling Co., Watertown, N. Y. "Garland Corn & Oats"	Watertown	G	12.	4.	11.	Corn and oats.
			F	13.9	3.9	3.1	Ground corn and oats, approximately 3.5 per ct. barley present.
	WHEAT BRAN AND CORN BY-PRODUCTS:						
7859	Empire Grain & Elevator Co., Binghamton, N. Y. "Egee Mixed Feed"	Messengerville	G	12.5	4.	9.	Maizo red dog flour and wheat bran with ground screenings not exceeding mill run.
			F	12.7	7.2	4.3	Wheat bran containing traces of ground screenings, white corn flour.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	WHEAT BRAN AND CORN BY-PRODUCTS (*concluded*)		*Per ct.*	*Per ct.*	*Per ct.*	
0181	Everett & Treadwell Co., Kingston, N. Y.	Kingston	G* 11.5	3.5	——	Ground corn, corn bran, ground oats, wheat middlings.
	"C. O. & W. Feed"		F* 11.4	3.2	5.	As certified.
7829	General Flour & Feed Co., Syracuse, N. Y. "Standard M & S"	Syracuse	G 10.	3.	10.	Wheat bran, Buffalo meal which is composed of corn and cob meal, the amount of cob used being the same as though ear corn was ground cob and all.
			F 12.8	4.7	6.8	Wheat bran, corn and cob meal.
8109	Indiana Milling Co., Terre Haute, Ind.	Poughkeepsie	G 12.	3.	16.	Wheat bran with ground screenings not exceeding mill run, cob meal.
	"Holstein Feed"		F 11.2	3.2	16.1	Wheat bran, containing ground screenings, cob meal.
6396	Indiana Milling Co., Terre Haute, Ind. "Sterling Feed"	Darien Center	G 10.	3.	16.	Wheat bran with ground screenings, not exceeding mill run, ground corn, cob meal.
			F 10.4	3.	14.9	Wheat bran containing traces of ground screenings, ground corn, cob meal.
7794	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Fancy Mixed Feed"	Poland	G 12.5	4.	9.	Made from maize red dog flour and wheat bran with ground screenings not exceeding mill run.
			F 14.1	6.9	4.7	Wheat bran containing traces of ground screenings, white corn flour.
8317	D. F. Sprague,		G ——	——	——	Bran and meal.
	Harrisville, N. Y. "Bran and Meal"	Harrisville	F 11.3	2.9	4.7	Wheat bran containing traces of ground screenings, corn meal.

	WHEAT MIDDLINGS, RYE MIDDLINGS, GROUND SCREENINGS:					
8279	Wm. Hamilton & Son, Honeoye Falls, N. Y. " Middlings "	Rome	G 16.2 F 16.1	4.75 5.5	4.4 4.7	Wheat middlings, rye middlings, traces of ground screenings.
8032	Hecker-Jones-Jewell Milling Co., New York, N. Y. " H Middlings with Mill Run of Screenings "	Valley Stream	G 16.5 F 17.3	4.75 5.1	8.25 6.8	Made from pure wheat. Wheat middlings, rye middlings, ground screenings.
085	George Urban Milling Co., Buffalo, N. Y. " Wheat and Rye Middlings with Ground Screenings not Exceeding Mill Run "	Buffalo	G 16. F 16.1	4.5 4.6	9.5 5.2	Rye bran, rye middlings, wheat middlings and a small amount of ground screenings.
	CORN FEED MEAL:					
061	Buffalo Cereal Co., Buffalo, N. Y. " Yellow B Corn Meal "	South Alabama	G —— F 12.1	—— 7.8	—— 4.7	Corn feed meal.
8614	Empire Mills, Olean, N. Y. " Corn Feed Meal "	Moravia	G 8.8 F 8.9	3.8 3.8	2. 2.5	Corn feed meal.
7959	Federal Milling Co., Lockport, N. Y. " Corn Feed Meal "	Brockport	G —— F 10.1	—— 5.6	—— 4.7	Corn feed meal.
7894	General Flour Feed Co., Syracuse, N. Y. " Corn Meal "	Syracuse	G —— F 9.2	—— 4.5	—— 1.9	Corn meal.
7389	A. H. Herrick & Son, Watertown, N. Y. " Herrick's 'C' Meal "	Watertown	G 9. F 9.2	3. 3.4	5. 1.5	Corn meal, corn feed meal. As certified.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	Per ct.	Per ct.	
	CORN FEED MEAL (*concluded*):					
8627	The Lake Erie Milling Co., Toledo, O. "Molletts A A A Feed Meal"	Syracuse	G* — F* 9.2	— 4.1	— 2.	Made from whole corn with corn meal for table purpose taken out. Corn feed meal.
7985	Phelps & Sibley Co., Cuba, N. Y. "Yellow Corn Feed Meal A"	Canisteo	G — F 9.0	— 3.9	— 1.8	Corn meal.
	BARLEY BY-PRODUCTS:					
8045	American Malting Co., New York N. Y. "Hully Maltsprouts"	New York	G 15.66 F 15.	1.5 1.4	16.4 16.9	Barley hulls, small amount of malt sprouts and malted barley.
8047	American Malting Co., New York, N. Y. "Standard Maltsprouts"	New York	G 21.09 F 19.5	2.1 2.1	12.3 10.5	Barley hulls, malted barley, malt sprouts.
8516	A. V. Smith & Bro., Marcellus Falls, N. Y. "Barley Middlings"	New Berlin	G 13. F 15.1	3. 4.3	12. 8.7	Barley middlings, barley hulls.
8602	A. V. Smith & Bro., Marcellus Falls, N. Y. "Barley Middlings"	East Syracuse	G 13. F 13.9	3. 4.2	12. 8.2	Barley middlings, barley hulls.
7842	Ryan Bros., Jamesville, N. Y. "Barley Middlings"	Syracuse	G 12. F 13.9	3.5 3.9	7.8 6.8	Barley middlings, barley hulls.
8622	Ryan Bros., Jamesville, N. Y. "Barley Middlings"	Syracuse	G 12. F 13.3	3.5 4.1	7.8 8.1	Barley middlings, barley hulls and a small amount of ground oats.

	RYE BY-PRODUCTS:						
0164	Barber & Bennett, Albany, N. Y. "Rye Feed with Ground Screenings not Exceeding Mill Run"	Albany	G	13.75	3.	6.5	
			F	14.7	3.2	4.2	Rye bran, rye middlings and a small amount of ground screenings.
8861	The Boutwell Milling & Grain Co., Troy, N. Y. "Rye Feed with Ground Screenings not Exceeding Mill Run"	Central Bridge	G	13.5	3.	6.	
			F	13.4	3.3	3.6	Rye bran, rye middlings and a small amount of ground screenings.
0364	Geo. C. Callanan, Castleton, N. Y. "Rye Bran"	Castleton	G	——	——	——	
			F	14.9	3.3	3.5	Rye bran.
8284	The Commercial Milling Co., Detroit, Mich. "Fine Rye Middlings"	Rome	G	14.	3.	4.5	
			F	14.5	3.	4.1	Rye bran, rye middlings, approximately 0.8 per ct. foreign materials present, consisting mainly of buckwheat products.
8087	John L. Ederer, Castleton, N. Y. "Rye Feed with Screenings not Exceeding Mill Run"	Castleton	G	——	——	——	Rye bran, rye middlings and ground mill run of screenings.
			F	14.3	3.6	4.5	Rye bran, rye middlings, traces of ground screenings.
8086	John A. Geiger, Niverville, N. Y. "Rye Feed"	Niverville	G	——	——	——	Rye bran, rye middlings and ground mill run of screenings.
			F	14.3	3.3	3.8	Rye bran, rye middlings, traces of ground screenings.
8278	Globe Milling Co., Watertown, Wis. "Rye Feed"	Rome	G	14.	3.	7.	
			F	15.	3.5	5.7	Rye bran, rye middlings, traces of ground screenings.
0368	Roye & Palmer, Nassau, N. Y. "Rye Feed"	Nassau	G	——	——	——	
			F	14.	3.1	3.4	Rye bran, rye middlings and a small amount of screenings.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.		Crude protein.	Crude fat.	Crude fiber.	Ingredients.
	RYE BY-PRODUCTS (*concluded*):			*Per ct.*	*Per ct.*	*Per ct.*	
0362	Wm. Servoss & Son, Amsterdam, N. Y. "Rye Bran"	Amsterdam	G*	——	——	——	
			F*	14.6	3.1	3.9	Rye bran.
0363	Wm. Servoss & Son, Amsterdam, N. Y. "Rye Middlings"	Amsterdam	G	——	——	——	
			F	12.3	2.6	2.2	Rye middlings.
089	George Urban Milling Co., Buffalo, N. Y. "Rye Feed with Ground Screenings not Exceeding Mill Run"	Buffalo	G	16.	2.	9.5	
			F	16.	3.7	5.7	Rye bran, rye middlings and a small amount of ground screenings.
8444	Van Vechten Milling Co., Rochester, N. Y. "'Irving Mills' Rye Feed"	Rochester	G	14.	2.	13.	By-product of the manufacture of rye flour, remainder of the ground grain after the flour is taken out.
			F	14.6	3.4	4.1	Rye bran, rye middlings.
7980	The Van Vechten Milling Co., Rochester, N. Y. "Rye and Rye Screenings"	Rochester	G	——	——	——	Rye and rye screenings.
			F	12.3	3.2	6.7	Rye screenings consisting largely of rye, light and immature oats and hulls.
7893	Washburn-Crosby Co., Minneapolis, Minn. "Pure Rye Middlings"	Syracuse	G	14.	3.	6.	
			F	15.9	3.5	5.1	Rye middlings containing a trace of ground screenings.
0193	Not given "Rye Feed"	Albany	G	——	——	——	
			F	14.	3.2	3.8	Rye bran, rye middlings and a small amount of screenings.

	GROUND SCREENINGS:						
083	Henry & Missert, Buffalo, N. Y. "Holstein Milk Food"	Buffalo	G	15.	10.	14.	Ground flax seed and flax screenings containing weed seeds.
			F	16.4	13.6	10.8	Ground screenings from flaxseed consisting largely of flaxseed and weed seeds.
7487	Miller Coward & Co., Darien Center, N. Y. "Ground Screenings"	Darien Center	G	——	——	——	
			F	13.4	6.3	9.5	Wheat screenings consisting largely of ground wheat, weed seeds and pieces of straw and stems.
052	Nowak Milling Corporation, Buffalo, N. Y. "Ground Screenings"	Varysburg	G	——	——	——	Said to be composed of flax screenings, ground.
			F	11.2	7.4	19.2	Ground flax screenings.
051	F. M. Richards, Alexander, N. Y. "Ground Wheat Screenings"	Alexander	G	——	——	——	Ground screenings from wheat and other grains.
			F	11.9	2.9	3.7	Ground wheat screenings.
6382	Tonawanda Valley Mills, Attica, N. Y. "Ground Grain Screenings"	Attica	G	12.	5.	13.	
			F	14.5	7.2	13.3	Ground screenings, mainly from buckwheat.
	MISCELLANEOUS:						
7388	Agricultural Products Corp., Cape Vincent, N. Y. "H-U Pea Meal"	Cape Vincent	G	19.21	1.75	21.56	Said to contain peas and pea hulls.
			F	18.8	1.3	13.3	As certified.
7120	American Hominy Co., Indianapolis, Ind. "Homcoline Feed"	Roxbury	G	17.	5.	7.	
			F	18.	7.4	5.	Corn germ meal.
0382	Corn Products Refining Co., New York, N. Y. "Argo Corn Oil Cake Meal"	Montgomery	G	20.	9.	10.	Corn oil cake meal.
			F	23.1	11.4	8.1	Corn germ meal.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS (*concluded*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	MISCELLANEOUS (*concluded*):					
7998	Corn Products Refining Co., New York, N. Y. "Diamond Hog Meal"	Tuscarora	G* 20. F* 22.5	9. 8.7	13. 8.6	Corn oil cake meal Corn germ meal.
8298	Eagle Roller Mill Co., New Ulm, Minn. "Superb Red Dog"	Central Square	G 19.48 F 18.6	5.43 4.9	4.73 3.8	Red dog. Red dog flour.
8288	The Hecker Cereal Co., New York, N. Y "Oathulls"	Camden	G 3. F 2.2	1.5 0.6	31. 31.6	Re-ground oat hulls.
7319	The H-O Mills, Buffalo, N. Y. "Force Screenings"	Buffalo	G 11. F 15.1	3. 5.8	9. 2.8	Wheat, salt. Refuse from the manufacture of cereal breakfast food made from wheat and salt.
8247	Hottelet & Co., Milwaukee, Wis. "Dried Beet Pulp"	Schenevus	G 8. F 8.2	0.5 0.5	20. 18.3	Dried beet pulp. Dried beet pulp.
8465	The Larrowe Milling Co., Detroit, Mich. "Dried Beet Pulp"	Elmira	G 8. F 8.8	0.5 1.4	20. 18.8	Dried beet pulp.
0602 •	Mutual Rice Co., Inc., New York, N. Y. "Rice Feed"	New York	G 12. F 12.6	11. 13.1	10. 10.	Rice bran, broken rice and rice hulls. As certified.

8260	The Northwestern Consolidated Mlg. Co., Minneapolis, Minn. "X X X Comet"	Oneonta	G 16.5 F 18.4	4. 5.3	3. 2.5	Pure wheat product composed of red dog wheat flour. Red dog flour.
8052	Oil Seeds Co., Bayonne, N. J. "Coco Brand Cocoanut Meal"	Southampton	G 20. F 22.8	7. 9.5	10. 7.1	Cocoanut oil meal.
8051	Oil Seeds Co., Bayonne, N. J. "Peanut Oil Meal Alpha Brand"	Southampton	G 40. F 38.8	7. 10.5	7. 3.1	Peanut oil meal.
8053	Oil Seeds Co., Bayonne, N. J. "Peanut Oil Meal Beta Brand"	Southampton	G 30. F 30.6	7. 9.3	8. 7.9	Peanut oil meal.
8188	Charles Pope, Chicago, Ill. "Dried Beet Pulp"	Brewster	G 8. F 8.6	0.50 0.9	20. 18.2	Residue of sugar beets dried after extraction of sugar Dried beet pulp.
8259	Purity Oats Co., Davenport, Ia. "Purity Reground Oat Hulls"	Oneonta	G 6.73 F 6.1	2.71 1.9	32.65 26.7	Oat meal mill by-products (oat hulls, oat shorts, oat middlings).
8292	Red Wing Milling Co., Red Wing, Minn "Bixota Red Dog"	Williamstown	G 12.7 F 15.4	4. 3.5	1.1 1.1	Red dog. Red dog flour.
0560	The Torula Company, Buffalo, N. Y. "Protorul"	Buffalo	G 47. F 44.3	2.1 0.8	1.7 0.1	Torulae, fungi, saccharomyces. Yeast by-product.

* These letters indicate, respectively, Guaranteed and Found.

APPENDIX.

I. Popular Editions of Station Bulletins.

II. Periodicals Received by the Station.

III. Meteorological Records.

POPULAR BULLETIN REPRINTS.

APPLE APHIDES AND THEIR CONTROL.*

F. H. HALL.

Plant lice important apple pests. Plant lice, or aphides, have been a source of irritation to fruit growers and farmers for years; but it is doubtful if the owners of apple orchards realize fully how injurious these pests may be when present in large numbers. Recent studies made by the Station give some data on the different injuries due to plant lice, and prove that steps necessary for their control merit the attention of every orchardist whose trees may be invaded.

The most prominent sign of the presence of the tiny pests is the curling and dwarfing of the leaves. These malformations are often serious enough to be a severe drain on the vitality of the tree and to reduce the storage of food materials needed to nourish the fruit buds for the next year's crop — a factor whose effect is very difficult to estimate for any one season, but sometimes quite evident during the year following a very severe infestation. Were severe aphis attacks to recur annually in any orchard, the result would undoubtedly soon be a marked decline in the general vigor and productiveness of the orchard.

But leaf infestation, alone, may have a decided effect even on the fruit-yield of the same season. Exact measurements were made, through the season of 1915, of Rome apples accompanying infested clusters of leaves but not themselves attacked by the insects. These apples, measured late in June, averaged only $\frac{7}{8}$ inch in diameter, and similar fruits uninfluenced by aphides averaged nearly $1\frac{1}{4}$ inches; while in October, when ready to harvest, the average transverse diameter of the apples of aphis-infested leaf-clusters was less than 2 inches,— that is, under market requirements,— while the check fruits averaged almost $2\frac{7}{8}$ inches.

When the fruits themselves are attacked by the plant-lice, the effects are immediate, continuous, and much greater than when only indirectly affected through the leaves. Normal Rome apples are somewhat flattened in the direction of the axis, the flattening becoming slightly more marked as the fruit enlarges; but apples of this variety, when attacked by aphides, showed much less proportional

* A reprint of "Popular Edition" of Bulletin No. 415; for regular edition see p. 297.

increase in transverse diameter; so that in apples from clusters severely or moderately infested the length, during June and part of July, was greater than the width; and in those from clusters only slightly affected the two diameters were approximately equal. The apples then began to broaden out somewhat; but were always longer, proportionately, than normal Romes.

This interesting peculiarity in the rate of growth was of slight importance, however, as compared with the small size of the injured apples and the very frequent cases of malformation. As already stated, the sound apples averaged practically $2\frac{7}{8}$ inches in diameter and those near infested clusters of leaves slightly less than 2 inches; but those any lice attacked directly averaged less than $1\frac{3}{4}$ inches while those from severely infested clusters were less than $1\frac{1}{4}$ inches across at the end of the season. Many apples from infested clusters were one-sided or otherwise deformed.

When the infested apples were sorted, only two out of forty-nine were found of marketable size and shape; but all of the thirty-one checks were normal in shape and ranged from $2\frac{1}{4}$ to $3\frac{3}{8}$ inches in diameter.

Species of aphides.

These injuries during 1915 in orchards about Geneva were largely due to the work of the rosy aphis, but two other species, the oat aphis and the green aphis, were also found in considerable numbers, though doing comparatively little injury. Through the apple-growing sections of the State as a whole, the damage from plant lice in 1915 was not great, but in occasional orchards near Spencerport and Wolcott and in other localities, as about Geneva, the insects were numerous enough to do much harm,— undoubtedly more than was fully realized by the owners of the orchards.

Time of appearance.

The first brood of the rosy aphis had probably all emerged from the eggs before the last week in April, when the apple buds had broken so that the tips of the leaves were beginning to project from those most advanced. By the time pink was beginning to show on the cluster-buds the young of the second brood were appearing and clustering on the blossom stems and the under surfaces of the leaves. At this time the oat aphis was more abundant than the rosy aphis, as the females (stem-mothers) of the former species mature earlier and reproduce at a more rapid rate. This species remains on apple only until the middle of May and the succeeding week or ten days, after which the winged forms of the earlier broods then appearing pass to other host plants. The period of activity of the early broods of green aphis coincides quite closely with that of the oat aphis, but its work about Geneva during 1915 was mainly confined to the succulent tissues of the terminal growths and water-sprouts. This work was not serious in its effects; as the lice appeared to abandon the aging leaves, in succession, for those newly opened, not seriously curling or injuring any of them. In a Gilli-

flower orchard near Wolcott, however, the green aphis did considerable harm to blossoms and severely damaged the foliage.

Many remedial practices ineffective.

Plant lice generally, and particularly those on fruit trees, are difficult to treat successfully; and many remedies and methods of control formerly, and even currently, recommended have proven ineffective in practice. The eggs of aphides, in which form the insects pass the winter, are exceedingly resistant to the ordinary contact insecticides.

The young appear so early in the season, are so minute and inconspicuous, and so soon become sheltered from spray treatments by entering the opening buds and by the curling down over them of the leaves they attack that they too often escape detection and treatment until it is so late that effective action against them is impossible.

Station tests.

The experience of 1914 and some earlier work indicated that the best chance for success lies in an attack upon the newly-hatched young, before they have found shelter; that is, during a comparatively brief period just before the opening of the buds. At this time the little pests are quite susceptible to spray influence and are readily reached by spraying without using excessive amounts of material. Accordingly the Station tests of 1915 were directed toward ascertaining the time limits for successful spraying, the best materials to use and the extent of the protection secured. The tests immediately under Station observation in its orchards at Geneva were three in number, one on Rome trees about 20 years old, using lime-sulphur and nicotine as an insecticide, one on mixed varieties of apples using various insecticides; and one on young seedling trees with various mixtures, including a preliminary test with nicotine solution and lime.

As auxiliary experiments, the Station cooperated with agents of the State Department of Agriculture in spraying ten commercial orchards in Niagara and Orleans counties.

In all the Station treatments much care was taken to make the applications at the right time to catch the aphides on the buds, with variations of a few days to determine exactly what condition of the buds is the best index of the time to spray. High pressure was used and nozzles of the common type giving a rather coarse spray. Such thoroughness was enforced that the buds were well drenched,— an essential to success in treating these pests.

Time to spray.

In the Rome orchard the spraying was done on three days, April 24, 26 and 27, about 10 gallons per tree of lime-sulphur and nicotine (one-to-eight dilution of 32° B. lime-sulphur, with $\frac{3}{4}$ pint of 40 per ct. nicotine solution to each 100 gallons). On the first date the buds were still compact with merely the tips of the leaves showing green. At this date, or somewhat earlier, as

other tests proved, the first brood of plant-lice of the three species had all emerged and were in their most unprotected condition, so the treatment at this time was very effective. Those made three days later were equally successful and all without injurious effects on the buds or foliage. On trees of mixed varieties the applications were begun six days earlier (April 18, 19 and 20) when the buds on most of the varieties were still quite compact, but with leaf tips just showing green in some cases. These treatments were as effective against the plant-lice as those made a week later on the Romes, proving that, even in this comparatively short season for bud development, there was a period of about ten days when aphides could be easily and effectively reached. In ordinary seasons this period for successful aphis treatment would probably extend over two weeks. The trees in the orchard of seedlings were affected mainly by the green aphis, with quite a few of the oat aphis early in the season. As the green aphis remains on the apple during the entire season, repeated treatments may be necessary to control the species unless perfect success is secured by the first application. In this orchard, therefore, bud treatments with various insecticides were made on April 19 and 20, with subsequent applications on some plats on June 22, July 10 and August 2.

General results. In the bearing orchards the oat aphis was most abundant when the treatments were made, scarcely a bud being free from the stem-mothers and young of this species, with scattered numbers of the rosy aphis. After treatment both practically disappeared from the treated trees; and very few were found on these trees at any time later in the season. On the check trees, however, the oat aphis rapidly increased in numbers previous to its migration to other host plants; and the rosy aphis, never so numerous as the other species, increased rapidly during late May and early June, so that by the middle of this month they had become plentiful enough to do appreciable damage to both fruit and leaf clusters. The rapid multiplication of this species from the small numbers seen early in the season was a rather surprising feature of the studies. Like the oat aphis, the rosy aphis does not remain on the trees throughout the summer, and in 1915 practically disappeared from the orchards in late June. In work against green aphis in the seedling orchard practically complete eradication of the pests was secured by the bud spraying with various insecticides; but the check trees always showed considerable infestation, and as the season advanced the winged forms migrating from the check trees to the treated ones, with the multiplication of the insects from the few females that escaped the first treatment, reinfested the sprayed trees. Comparatively little injury was done, however, even on the checks, owing to the habit of this species, previously referred to, of shifting to the fresh leaves, not remaining long enough on any to injure them materially. However, the effect

of accumulated injuries became increasingly apparent on the check trees as the season advanced, in the presence of curled and distorted leaves, discolored and smutty from honeydew and sooty fungus, followed by more or less browning of the leaves, some defoliation and occasional instances of dwarfing and killing of the tips of the new growth. The spray treatments of whatever kind effectively protected the sprayed trees.

Some data of results. It is hardly necessary to discuss the effects of the treatments in detail; but the following table shows a summary of the results of the experiments in the Rome orchard, with interplanted trees of other varieties, and in the older orchard of mixed varieties.

TABLE I.—SUMMARY OF EXPERIMENT AGAINST ROSY APHIS.

IN ROME ORCHARD WITH INTERPLANTED VARIETIES

NUMBER AND VARIETY OF TREES.	Treatment.	Centers of infestation.	Fruits injured.	Leaves curled.
		No.	*No.*	*No.*
18 Rome	Sprayed	46	33	172
10 Mixed varieties	Sprayed	8	0	29
7 Rome	Not sprayed	319	279	1,323
Average per sprayed tree, Rome		2.55	1.83	9.55
Average for all sprayed trees		1.93	1.17	7.17
Average per unsprayed tree, Rome		45.57	39.85	189

IN ORCHARD OF MIXED VARIETIES

TREATMENT.	Number of trees.	Centers of infestation.	Fruits injured.	Leaves curled.
		No.	*No.*	*No.*
Lime-sulphur and nicotine solution	21	569	299	2,081
Nicotine solution and soap	17	19	11	41
Sodium sulphide and soap	5	295	70	1,118
Carbolic acid emulsion	23	976	710	3,736
Check, no treatment	14	3,086	2,777	13,320

AVERAGES PER TREE

Lime-sulphur and nicotine solution	27	14	99
Nicotine solution and soap	1	1—	3
Sodium sulphide and soap	59	14	224
Carbolic acid emulsion	42	31	162
Check, unsprayed trees	220	199	951

The table plainly indicates that on both Romes and mixed varieties the lime-sulphur and nicotine gave excellent results, excelled only by the nicotine and soap, which has somewhat better spreading qualities. The latter, also, of the four combinations used on bearing trees, resulted in no injury whatever to foliage or fruit; but the injurious effects from the other mixtures, except sodium sulphide and soap, were practically negligible. The sodium sulphide, though, was decidedly injurious, as the buds treated by it began to show brown within a few days and were retarded a week in blossoming when not killed. On the lower branches where the effects of the treatment were most evident, many of the fruit spurs were killed and the leaves were few and small. The trees recovered somewhat during the season, but gave very small yields of fruit and still showed other signs of injury at picking time.

In the seedling orchard the nicotine and soap spray was somewhat more rapidly effective than lime-sulphur and nicotine, though the final effects of the two combinations were not markedly different. A new preparation, nicotine solution and lime alone, was also tried, in the effort to find something that would serve as a deterrent, if not as an actual destroyer of the aphis, over a longer period than that covering the activity of the other combinations. These have practically no effect after the mixtures have thoroughly dried on the trees. As the green aphis remains on the apple throughout the season and migrates from tree to tree, the foliage and fruit that have been cleared of the pests by the bud spraying may become reinfested. The nicotine and lime combination makes a very adhesive coating on the trees and lasts a long time. It is apparently quite effective, but the investigation has not been continued long enough as yet to justify recommending this combination as an aphidicide (plant-lice destroyer).

Auxiliary experiments. In the commercial orchard experiments the work was mainly under the supervision of A. B. Buchholz and L. F. Strickland, Horticultural Inspectors of the State Department of Agriculture, and was designed to test the feasibility and efficiency of bud-spraying in the hands of growers. The same principles governed the work as at Geneva, careful observation of buds to note condition and presence of plant lice, and thorough drenching when the tips of the leaves were just showing (April 21, 22 or 23) with lime-sulphur and nicotine.

In two of the orchards the rosy aphis did not appear, but in the other eight more or less evidence of its work showed on the check trees, while the oat aphis and green aphis were quite abundant in some orchards and in scattering numbers in almost all of them. Aphis injury was decidedly reduced on the sprayed trees in every instance where check trees suffered appreciably, the foliage showing much smaller percentages of curled, brown or yellow leaves, less defoliation and frequently a distinctly better setting of fruit. The

general condition of the sprayed trees was excellent; and had the outbreak of any of the species of plant lice been a bad one, undoubtedly the spraying would have made a notable difference in the crop returns.

Formulas and methods. The following insecticides were used in one or more of the experiments discussed:

(1) Lime-sulphur and nicotine solution:

Lime-sulphur solution (32° B.)	11 gals.
Nicotine solution (40 per ct.)	¾ pint.
Water	89 gals.

(2) Soap and nicotine solution:

Soap	5 lbs.
Nicotine solution (40 per ct.)	¾ pint.
Water	100 gals.

(3) Sodium sulphide and soap:

Sodium sulphide (56 per ct. sul.)	15 lbs.
Soap	5 lbs.
Water	50 gals.

(4) Crude carbolic-acid emulsion:

Soap	15 lbs.
Crude carbolic acid	1 pint.
Water	100 gals.

From the standpoint of safety to expanding buds and leaf tissues, and effectiveness against insects, the most satisfactory combination is three-fourths of a pint of nicotine solution (40 per ct.) to one hundred gallons of lime-sulphur solution at winter strength for bud treatment or to one hundred gallons of lime-sulphur at summer strength with arsenate of lead for foliage applications. While this combination lacks somewhat the spreading properties of soap mixtures, oil emulsions or nicotine solution with soap, this deficiency is probably more than compensated by the saving in labor in avoiding an extra application and by the thoroughness of spraying in the bud treatment when lime-sulphur is directed also against the San José scale. Drenching of the trees with this combination as the buds are breaking may injure the tips of the unfolding leaves. However, the damage is usually inconsequential and should cause no apprehension.

Whatever the insecticide selected, great care should be taken to apply it at the proper time, as shown by the condition of the buds and presence of the lice, as discussed on previous pages, and to be thorough in the work, covering every part of the buds and tender tissues near them.

[Plates XXXIII and XXXVI illustrated this "Popular Edition."]

BREEDING RASPBERRIES.*

F. H. HALL.

Laws of heredity require much study.

With commercial plant breeders the origination of profitable new varieties is the first consideration. Unless such results follow, the work is counted a failure and is usually soon discontinued. At some experiment stations, however, and at other research institutions and breeding grounds, the discovery of the laws which govern the inheritance of characters and knowledge of the way those laws act in actual practice are of prime importance,— the immediate development of new varieties merely incidental. Were this not the case, the work at this Station with raspberries, continued now for more than twenty-five years, would seem of little consequence; for until within a very few years, from thousands of seedlings grown, less than half a dozen varieties of merit had arisen, and perhaps only two that are decided additions to the list.

But, building on principles and methods of application made clear by the earlier work, progress in originating valuable new varieties has been much greater in the past five years than ever before. It is believed that there is growing on the Station trial plats the foundation stock of many raspberry varieties better than any now grown.

Yet advance in knowledge of the heritable factors that make up the good raspberry,— black, red, or purple,— has been very slow; for these characters, though apparently simple to the casual observer, are themselves often made up from several factors, each of which exerts an influence and each of which may be inherited independently from those allied to it or, on the other hand, may be inseparable from some other factor with which, on the surface, it has no apparent connection.

Purple raspberries hybrids.

One result of the work in breeding purple raspberries has been to prove that this type of bramble does not constitute a true species, *Rubus neglectus*, but that such plants are true hybrids, or descendants of hybrids, between the black-cap and the red raspberry. Crosses were made between June, a Station red seedling, and two black-caps, Cumberland and Smith No. 1, giving more than 800 seedlings. Many of these seedlings, particularly those from Smith No. 1, were very promising, with bushes more vigorous than those of either parent, with large, firm fruit, a little later than that from the parents, and, on some plants, of a rich, glossy purple.

* A reprint of " Popular Edition " of Bulletin No. 417; for regular edition see p. 481.

All of the seedlings from June and Smith No. 1 were purple raspberries; and all but a few of the June-Cumberland cross were also purple-caps, the variants being yellow-fruited berries, due to a hidden factor, or factors, for that color in the black of Cumberland.

Yet Columbian, a purple raspberry whose history indicates that it came from direct crossing of a black and a red, did not, when self-fertilized, give one-fourth red seedlings and one-fourth black, as would be expected from Mendel's laws, but practically all were intermediate in character and almost none red raspberries either in color of fruit or in cane characters, and none showed any tendency to propagate by suckers as does the red raspberry.

Varieties as parents. In attempting to secure desirable purple raspberries, it seems best to make the red-black cross, rather than to use purples themselves as parents; and for this purpose, as well as for crossing within the colors and for "selfing" (i.e., breeding pure seedlings of any variety), the choice of parent varieties is very important. The varieties that do best in the commercial or home plantation do not always give the best progeny, and *vice versa*. For example, Cumberland would probably be ranked ahead of Smith No. 1 as a commercial berry; yet from crosses of these with the same red raspberry twice as many seedlings with Smith No. 1 as a parent were retained for testing as of those with Cumberland. It should be said that, crossed with June, even Cumberland gave many good seedlings.

As a parent Marlboro ranks high. Its seedlings tend to produce early fruit, of good size, often rather soft and frequently lacking in quality, bushes stocky rather than sprawling, rather poor as plant makers and often with a tendency toward few spines, especially when crossed with June, one of its own progeny.

Herbert seedlings lack vigor, produce low-growing plants and large, conical berries, which are sometimes too soft. Herbert should be crossed with a vigorous variety whose fruit needs larger size.

Cumberland ranks poor as a parent, though giving good results when combined with Smith No. 1. Of all Cumberland seedlings without Smith No. 1 influence, only 7 per ct. were retained.

Smith No. 1 is a useful parent. Of pure seedlings of this variety and of purple descendants nearly one-fourth were retained for a second test, and of seedlings with other black-caps 30 per ct. showed merit. The qualities transmitted by this variety appear to be productiveness, and large size, fine appearance, firmness and good quality of fruit. With only two possible exceptions, its progeny indicate that the black color in the fruit is a pure character.

Are fruit colors pure? Study of the inheritance of fruit color indicates that neither black nor red is pure in some cases, but that each may conceal a factor for yellow; and that each may also be made up of two or more factors which modify or limit the purity of the basal color. Smith No. 1 is

probably a pure black, but Cumberland, Hilborn and Palmer each have yellow descendants in small numbers; while Cuthbert, Marlboro, Herbert and June, among reds, also occasionally transmit yellow.

A pure black crossed with a red, even though the latter carry a yellow factor, will give only purples.

In the color-inheritance studies a rather interesting and possibly useful correlation of characters was observed, by which the undesirable yellow-fruited seedlings of any cross may be eliminated very early. In red crosses the distinction is very plain, but when blacks and reds are united, separation of the yellow from the purple seedlings is a little more difficult. The plants which produce yellow fruit lack the reddish tinge on the upper surface of the young leaves, which is a marked characteristic of the red-fruited varieties; and the gland-like tips of the leaf-serrations also are light yellowish green in color instead of being red or reddish. On the purple-fruited plants, the reddish markings are not so prominent, either on leaves or glands; but on the older leaves the gland-like tips of the serrations are always red, while the yellow-fruited kinds show no red. It is also believed that no red or purple shows on the dormant canes of the yellow-fruited plants.

Inheritance of cane characters.

Glaucousness, or bloom, on raspberry canes, a characteristic of many black-caps and some red raspberries, and the roughening of the bark due to shedding of the outer layer, seen on so many reds and a few blacks, both appear to be Mendelian dominant characters. That is, if the factor for rough bark and the factor for smoothness of bark are inherited by a plant, the rough-bark factor will prevail, as though the other were not present.

The tendency to reduction of spines, however, does not inherit in any simple Mendelian ratio, hence it is believed that two factors, possibly more, must be considered in the production of a spineless cane. Smith No. 1 transmits spines more strongly than does Cumberland.

Using new species.

The wild thimble-berry or flowering raspberry, *Rubus odoratus*, was used in crossing with the red raspberry, blackberry and dewberry, but with most of the attempts very few seeds resulted. With the Herbert red raspberry, however, good vigorous seedlings were secured in considerable number. These show plainly that they are true hybrids, with the flowering raspberry habit of bush and character of flower but with leaves palmate like those of the red raspberry while large and rough like those of the thimble berry. These seedlings flowered abundantly in 1915 but set few fruits, probably owing to absence of cross pollination.

The success of such hybrids as the purple raspberry and the loganberry emphasize the desirability of work in hybridization; and it is a possibility that the flowering raspberry may become a " go-between " by means of which to unite the blood of several species

WITLOOF CHICORY.*

F. H. HALL.

A new salad plant for New York truckers. Salads are now very popular on American tables as they have long been with European epicures. The crispness and delicacy of a well-made salad, with the novel flavor combinations and gustatory thrills made possible by judicious union of new plant tastes and aromas with the mild acids and rich oils used by expert chefs, have a peculiar appeal to delicate palates, long wearied of heavy meats and vegetables or cloyed by rich desserts and pastries. Consequently, in any of our large cities where surplus wealth accumulates, a ready market exists for any salad plant that pleases at once both eye and palate.

Such a plant is Witloof chicory; and since its culture in New York State is not only possible but practicable and easy it would seem that market gardeners and forcing-house men are missing an opportunity for a nice supplement to their revenues unless they grow it.

What is Witloof chicory? Witloof chicory is a Belgian development of the ordinary chicory whose roots are used as a coffee adulterant or coffee substitute and which has been cultivated to some extent in America, running wild in many sections to become a pernicious roadside and pasture weed with striking blue flowers.

The common chicory, or succory, has often been forced in winter to form heads or loose leaves (Barbe de Capuchin) for use in salads or to be cooked for "greens" as are dandelions. But Witloof (White-leaved) chicory is a better forcing plant, with larger roots than the common chicory, and with heavy, broad smooth leaves that make very attractive heads when properly grown. The plant is also known as Brussels chicory, from its supposed place of origin, and, improperly but most commonly in the markets, as "French endive."

* A reprint of "Popular Edition" of Bulletin No. 418; for regular edition see p. 510

Witloof chicory makes very attractive salads, white, crisp, faintly bitter but with a characteristic flavor most pleasing to practically all palates. The heads may also be used as a potherb, similar to spinach or dandelions, but are more delicate than either.

Great quantities of Witloof chicory have been grown about the larger cities of Belgium and France and sold for local consumption or sent to Germany, Switzerland, England, and, recently, to the United States. Before the war, Witloof was sold in London markets, undoubtedly with profit, at from 4 to 8 cents a pound. It then brought 25 or 30 cents a pound in New York markets and now, because of restricted growth and transportation difficulties, brings nearly double these prices.

Growing the plant. Realizing these conditions it seemed wise for the Station to ascertain whether Witloof chicory can be grown and forced readily and cheaply in New York State. Both growing the plants and forcing the heads prove to be easy and inexpensive.

The seed, imported for these tests from England but sold by many American seedsmen, is not expensive, and the growth of the plants to form forcing roots is simple. The seed may be sown any time in May in open ground, in rows eighteen inches apart and the plants later thinned to six inches apart in the row. Ordinary garden culture only is needed, but the plants should make a steady luxuriant growth, resembling large, smooth-leaved dandelions. The roots should be lifted just before the ground is liable to freeze, the leaves trimmed to within two inches of the crown, and the roots stored.

Forcing the heads. When needed for forcing, — January 3, in the Station test,— the roots should be placed in beds or boxes where moderate heat can be applied, first cutting them off at the bottom to a uniform length of 8 or 9 inches. For holding the roots any soil or sand will do, since the growth of the heads is from the food stored in the roots and does not depend at all on the soil fertility. The roots may be set quite close together, but not touching, upright in the soil and covered to the crowns. Various materials may be used for holding and bleaching the heads during their growth, but in the Station tests eight inches of clear sand was used with splendid results. This was placed on the bedding material as soon as the roots are set. One or more free applications of water should be made.

From experiments at different temperatures, from 50° to 60° F. would seem to be desirable, the latter probably preferable since growth is slower at the lower temperature. Higher temperature than 60° for any considerable period causes the leaves to shoot up rapidly and decreases the proportion of solid heads.

At these temperatures the leaves should begin to show through the eight inches of sand in about two weeks, when the heads are ready for harvesting.

Roots and heads.

In the Station tests four grades of roots were used; Extra, averaging 2 inches in diameter, Large, 1.4 inches, Medium, 0.9 inch, and Small, 0.6 inch. Of these the Large and Medium roots gave more than 70 per ct. of marketable heads, while the Extra roots produced too many divided and loose heads, or heads too large to serve satisfactorily as individual portions at table. The small roots produced many small heads, too slender for market purposes. The heads should be from four to six inches long, and weigh two to three ounces to suit the market best. In Europe they are packed in baskets holding 10 kilograms (22 lbs.); but the illustration on the title page shows a filled 3 lb. Climax basket, which makes a very satisfactory package for small American markets.

The heads grown in these experiments were pronounced excellent by local grocers who have handled imported Witloof, and far superior to the foreign product in crispness and delicacy.

[Plates LXXV and LXXVII were used to illustrate this edition.]

THE CABBAGE MAGGOT AND ITS WORK.*

F. H. HALL.

An old foe from Europe.

More than eighty years ago the cabbage maggot was described in Europe as a pest of cruciferous crops. It has been known in America nearly as long, but undoubtedly came from England or the Continent some time before, possibly as larvæ in turnips brought over for food on shipboard, but much more likely in the pupal form in sand used for ballast, which had been taken from places where cabbages, mustard or cruciferous weeds had grown.

In all northern latitudes where cabbage thrives, the maggot is one of the most serious pests of this crop and its relatives, cauliflower, radish, turnip, etc.; but it does little harm south of 45 degrees latitude in North America or 40 degrees in Europe. During certain seasons it is very destructive, while at other times it becomes so reduced in numbers by weather conditions and the work of its natural enemies that the damage it does is hardly noticeable.

Work of maggot on cabbage.

As a cabbage pest in America, the insect affects the early crop in the field and the late crop in the seed bed. The mature insects, which are flies, feed on the nectar of flowers, the sweet exudations of plants or the juices of over-ripe fruit, but do no particular harm by their feeding. The eggs are laid, usually below ground, where the young larvæ can feed on those parts of the plants that lack the green coloring matter, or chlorophyl. Not many true maggots feed on living tissue, but those of this species rasp and tunnel and burrow in the roots and underground parts of the stems of cabbage, cauliflower, radishes, mustard and mustard-like weeds, so that the plants are stunted, deformed and killed. Another closely allied species works on the onion.

The work of this insect on cabbage plants in the seed bed was described in detail in Bulletins 301 and 334 of this Station, with experiments that proved screening the beds the best and most

* A reprint of "Popular Edition" of Bulletin No. 419; for regular edition see p. 340.

economical method of preventing damage; and in Bulletin No. 382 the use of tar-paper pads was recommended, after very successful experimental trials, for the prevention of injury to early cabbage in the field. A future publication will discuss the work and control of the insect on radishes.

The present bulletin deals principally with points in the life history of the maggot, previously obscure or in dispute, to which study has been given for from three to five or more seasons.

Life history in brief.

The insect passes the winter in the pupal stage, mainly if not exclusively; the pupæ change in the spring to flies, which begin to emerge about the time Windsor cherries blossom and may continue to appear for three or four weeks. They deposit eggs very promptly, and these hatch in from three to five days. The larvæ feed about three weeks under ordinary conditions and then change to pupæ, in which form they remain about two weeks, normally, after which the flies again appear. This succession is repeated once or twice during the season, occasionally more, so that the insect is usually three-brooded, but may be two-brooded, or, under very unfavorable conditions, one-brooded, while with exceptionally favorable weather, a partial fourth brood may be produced. Of course the pupæ of the fall brood live longer than the normal two weeks, since they hibernate; and occasionally pupæ of the earlier broods may undergo the same experience.

The egg and egg-laying.

The egg is about one twenty-fifth of an inch long and one-third as thick, is glistening white in color, but marked with irregular longitudinal furrows. It is usually placed just below the surface of the ground on the roots of cruciferous plants, the choice of location being apparently determined more by the succulence of the tissue than by the variety of plant. The female examines various locations with the tip of the extended ovipositor, and, under observation, none has ever deposited more than one egg in a place; but the presence of eggs in clusters indicates that frequently many more than one are laid at a time. How many eggs each female lays cannot be stated definitely, since none of the large number of caged females oviposited, though given apparently favorable conditions for doing so. It is probable, however, as inferred from the eggs present in dissected females, from the apparent condition of the ovaries, and from comparisons with other flies, that each female may lay from 50 to 200 eggs.

The eggs hatch normally in about three and a half days, but the time may be hastened half a day by favorable conditions or retarded even more by unfavorable ones. In experimental tests increase in temperature up to about 80° hastened development, but no eggs hatched when the temperature was 105° or 62½°, nor when the eggs were kept in dry sand or exposed to light and air.

Larva. The larvæ are whitish maggots, slightly larger than the eggs on emergence, and increasing in size through three stages until they are from one-tenth to three-tenths of an inch long and from one twenty-fifth to one-twelfth of an inch in diameter, roughly cylindrical in form, tapering slightly toward the head. The later stages are marked by tubercles on various parts of the body, whose arrangement and form serve to identify the insect in the larval stage, since it differs from the larvæ of other flies only in such small points. The variation in size of the last-stage larvæ and the resulting pupæ is due to the fact that stress of circumstances, such as scarcity of food or unfavorable weather, causes the larvæ to pupate when only one-third to one-half the size they might attain.

Pupa and puparium. When changing to this quiescent stage, the pupa form, the skin of the larva hardens and contracts, forming a shell-like case, the whole looking much like some kind of a seed with irregular protuberances where the tubercles of the larva were. Within this puparium the pupa changes to the adult form. In this stage the greatest variation in length of the period of development occurs. Aside from the hibernation of the pupæ of the last brood, and probably of occasional individuals of earlier broods, which prolongs the pupal life for months, the normal two-week period may be varied to quite an extent by weather conditions. In tests on large numbers of pupæ kept where moisture and temperature could be varied within quite definite limits it was found that ordinary differences in the soil moisture, though quite wide, do not alter the length of the pupal period after development has begun; but that a marked deficiency of moisture, such as would cause a noticeable shrinkage of the insect within the puparium, would retard its development. High temperature, such as often occurs during the summer months in western New York, is unfavorable to normal growth of the pupa, as well as injurious to the larva, and seems to cause a retardation in development which may last until low temperature returns. It is undoubtedly this factor that does most to decrease the number of broods in certain seasons.

While these wide variations in heat and moisture have a general effect upon the pupæ, there seems to be a decided difference between individuals, so that a few pupæ when subjected to high temperatures mature more quickly than under normal conditions, while others, as indicated, "aestivate," or become dormant through some of the summer months, just as others hibernate through the winter months. It would seem that Nature insures the survival of enough individuals to continue the species, no matter how severe the weather conditions may be.

The pupæ are usually to be found from two to three inches below the surface of the soil, and within about the same distance or perhaps a little more from the roots of the plants on which they have been

feeding. They may occasionally be found in small numbers in hiding places upon the stumps of the cabbage left in the field after the heads have been removed, as the succulent buds and sprouts arising from such stumps appear to be a favorite feeding place for larvæ of the late fall brood. Removal and destruction of such cabbage refuse, and reduction of the number of mustard-like weeds in cabbage-growing districts will undoubtedly aid materially in reducing the numbers of the pest.

Adult. Though the pupæ usually lie only a short distance below the surface of the soil, the adults can penetrate many inches of earth. In plowing tests, turning the soil either six or nine inches deep did not interfere seriously with the emergence of the flies, either by reducing their numbers or greatly delaying the time of appearance. In pots, larger percentages of flies emerged when the pupæ were buried 10 or 12 inches in lightly compacted clay loam than when covered with only 2 or 4 inches of the soil.

The male fly is dark in color, with gray markings, thickly covered with fine hairs or bristles. The position of the tufts of bristles is an identification mark for the species. The female is lighter in color than the male, less bristly, as a whole, and lacking the particular tuft of bristles on one of the pairs of legs which serves to identify the male.

Enemies. Hot, dry weather in late summer and early fall is, without doubt, the greatest factor in diminishing the numbers of the cabbage maggot; but certain insects play a very prominent part in checking it. Among these are small beetles of the genus *Aleochara*, of which the immature forms of at least one species are probably parasitic in the larvæ, while the mature beetles feed upon that and other stages. The life history of other beetles of this group is not well known, but several species of them were either bred from cabbage-maggot larvæ or found in such close connection with the pest in some of its stages as to justify the conclusion that they attack it. In England twenty-five per ct. of the pupæ of the cabbage maggot examined by one investigator were found to be infested by beetles of this group.

Another enemy of the maggots is a minute wasp-like insect which lays its eggs on or in the host, so that the young of the parasite feeds upon and destroys the pupæ. On a screened cabbage-bed near Geneva, nearly one-fourth as many adults of this parasite were collected as of the maggot flies.

A mite also attacks the eggs and has been known to destroy large numbers of them; in one instance three of the mites destroyed twenty-eight eggs of the maggot fly in a single day. This mite is numerous in the cabbage fields about Geneva, and while exact data regarding its work were not secured, it must have been very active as an egg-destroyer, since as many as 200 maggot-fly eggs a day were known

to have been deposited about the cabbage plants; yet this mite and other enemies of the insect so reduced the numbers that very little injury was done to the cabbages.

Controlling cabbage maggot. To control the cabbage maggot about early cabbage the most effective means tested has been the use of small hexagonal pads or collars of sing e-ply tar-paper. These are cut with a slit from the edge to the center and shorter slits about the center so that they can be placed about the plants shortly after they are set, fitted about the stem, and pressed close to the ground. The flies then cannot reach the roots by crawling down the stem or along the surface of the soil. These pads can either be purchased at a small price, or made at home by cutting from the roll of tar paper with a simple tool. Applying them is a simple, rapid and inexpensive process, and the protection afforded is so good that the use of the pads is very profitable in seasons when the maggots are abundant. Injection of carbolic-acid emulsion about the roots of the plants has often been recommended, but in tests made at the Station the emulsion in strength great enough to destroy the maggots was also injurious to the cabbage plants.

For many years in certain cabbage-growing sections of New York it has been almost impossible to secure, in open seed beds of reasonable size, enough plants to set the cabbage fields planned; while purchase and shipment of the plants from outside the State is expensive. In early tests by private growers, screening the beds with cheesecloth did not prove very effective; since it was not then realized how carefully the protection must be arranged to exclude the insects.

Station tests, however, proved that a well-adjusted screen would not only exclude the maggot flies, but also shut out the flea beetles that are nearly as injurious, and would give larger, earlier and better plants through the effect of the screening on moisture and other conditions in the bed.

The practice is now very general over large parts of the cabbage-growing areas of the State and there regarded as indispensable. The cost is less than the amount spent for extra seed under the old conditions and the protection can easily be made perfect. Level soil should be selected for the beds, as free as possible from weeds and free from cabbage diseases. It should be thoroughly prepared and well fertilized before laying out the bed and putting up the screening, since further cultivation is not possible. Boards six, eight or ten inches wide may be used, united by tight joints at the ends and pressed firmly upon or into the soil so that no insects may enter at the ends or below the boards. Any low spots in the ground beneath the boards should be filled and the dirt banked slightly along the bottom of them.

Cheesecloth of 20 to 30 threads to the inch is stretched tightly over the bed, before the plants appear and attached to the boards

so no insects can enter along the edges. If the bed is large the cloth must be kept from sagging, which is best done by galvanized iron wires 4 or 5 feet apart lengthwise the bed supported by flat-topped stakes to which the wires are attached by staples, galvanized to lessen danger of rusting. The cheesecloth should be removed ten days or so before the plants are to be set, so that they may harden. If examination of the earth about the plants shows that eggs of the maggot flies are being laid, the plants should be set at once, shaking off the eggs with the soil.

[Plates XLII and XLVI were used to illustrate this edition.]

SOME DISAPPOINTING SEED POTATOES.*

F. H. HALL.

Sudden "running out" of strains.

In the spring of 1914, the Station received tubers of several varieties of potatoes grown in this State under the supervision of the United States Department of Agriculture. These potatoes had been produced during the very dry season of 1913, but the plants on which they grew were apparently healthy and the tubers were mostly of normal shape, fair size and good appearance. They were planted with the hope of securing seed from them for breeding experiments; but many of the resultant plants were so abnormal that it was unmistakably not wise to use any of them as foundation stock for breeding work.

The entire crop was turned over to the Botanist that he might study the diseases or troubles that led to the sudden development of the abnormalities. He selected one variety, Green Mountain Jr., for special study, of which about half the plants were abnormal and the others apparently normal. The tubers from these plants gave, in 1915, about 360 plants of which only about one in thirty was normal. That is, this particular strain of potatoes had, in two years, so "run out" from obscure causes that it was worthless. Some of the troubles noted have been given the names of spindling-sprout, curly-dwarf, mosaic, and leaf-roll; but though these troubles have been much studied, both at this Station and elsewhere, and both before and since this marked instance of their occurrence, little is really known as to their cause or causes, or their relationship to each other.

Other instances of deterioration.

The other varieties received from the same source as the Green Mountain Jr. were not given such careful study; but were grown under the Botanist's observation and gave very similar results. Of the State of Maine, tubers from six abnormal and four apparently normal hills were planted, resulting in 77 plants of which only 9 were normal; of Carman No. 2, 40 of 42 plants from two " normal " hills were apparently all right, but

* A reprint of " Popular Edition " of Bulletin No. 422; for regular edition see p. 97.

the other two were affected with mosaic and one was a dwarf; of Long Island Wonder, only one plant was normal out of 72 from equal numbers of "normal" and abnormal hills of the previous year. This one plant was from the bud-end seed piece of a tuber and the plant from the stem-end piece of the same tuber was severely affected with mosaic. Of the variety Knoxal, tubers from normal hills gave normal progeny, those from abnormal hills small plants affected with mosaic; of Rural New Yorker No. 2, only one hill of those apparently normal in 1914 gave all normal progeny in 1915, the other two giving larger or smaller proportions of dwarf or mosaic plants; and similar conditions marked the plants grown from Late Victor tubers.

The variety Ionia, from another source, behaved in the same peculiar manner. The plants from one normal hill gave a remarkably good yield of potatoes, at the rate of 419 bushels to the acre; but the tubers were of variable shape, not at all typical of the variety. Plants from another hill were of fair size, but not quite normal; while many of those from tubers of the third "normal hill" were small, with very light green foliage and symptoms of leaf-roll. Contrary to the usual experience, one of four plants from four tubers of an abnormal hill was large, normal, bore dark green, healthy foliage, and produced almost four and a half pounds of tubers.

Another unknown variety, affected with leaf-roll in its original locality, furnished 19 tubers for planting at Geneva; and every plant was affected with the same trouble, with no signs of mosaic or curly-dwarf.

A single tuber of Pride of Vermont, from a crop that won second prize in a potato growing contest in Connecticut, was planted in Geneva in 1913; its entire progeny was used for seed in 1914, and the progeny of three hills again used in 1915. The yield of the variety had continually decreased, without notable signs of plant deterioration except some rolling of the lower leaves, until, in the third year, a 40-foot row produced only 7¾ pounds of tubers. Other tubers of the 1914 crop left in the cellar to sprout showed unmistakable signs of "spindling-sprout."

A tuber of Green Mountain, from the crop that won first prize in the contest mentioned above, was planted, producing only one hill the first year owing to an accident. This gave a heavy yield and the progeny was used for seed the second year, 1914. The plants were all apparently normal except for a slight browning of the leaf edges; but the yield was not what was expected. In 1915 the tubers of part of the crop of 1914 were divided, and grown in three localities — Maine, Long Island, and northeastern New York. In all three places large proportions of abnormal plants appeared, those in both New York localities showing marked dwarfing but not true curly-dwarf, those in Maine, curly-dwarf and spindling-sprout, with some cases of mosaic.

Conclusions. As the troubles mentioned are so obscure, it is not thought best to give any description of them here; but some general conclusions relative to their behavior may be of interest, since the simultaneous "running out" of so many strains of potatoes, with the development of symptoms of one or more of the troubles, gave an excellent opportunity to test the liability of their transmission.

It is believed[1] "that leaf-roll, curly-dwarf and mosaic are closely related disorders due to the same general, undetermined cause. In some respects they behave like bud-varieties; but they present, also, important points of difference. All are transmitted through the seed tubers. The progeny of affected plants almost invariably become affected.

"The heredity of spindling-sprout is still undetermined and its cause is largely a matter of conjecture. However, it may be stated that spindling-sprout is not correlated with leaf-roll, mosaic or curly-dwarf.

"There is no evidence that any one of the four forms of degeneration named is communicable from one plant to another except through the medium of the seed tubers. They are not due to any parasitic organism. Neither are unfavorable soil or weather conditions of the current season responsible.

"In general, plants from different tubers of the same plant are similar; also, plants from different eyes of the same tuber usually resemble each other closely; but exceptions to both rules are frequent.

"Various combinations of normal, mosaic, leaf-roll and curly-dwarf plants may be obtained from the several tubers of one plant or even from the several eyes of one tuber.

Bearing on seed potato selection. "The best known method of combating leaf-roll and curly-dwarf is that of using for seed only tubers of normal plants. Undoubtedly, these and some other forms of disease and degeneration may be largely eliminated by the judicious selection of seed. Many potato growers who raise their own seed potatoes practice hill-selection with satisfaction and profit; and those who buy their seed are beginning to look upon certified seed potatoes as the best solution of their seed-potato problem. The subject of seed selection is one of much interest at present. What light does this study throw upon it?

"*First:* It is plain that high yield, alone, is not a guaranty of productivity in the progeny of the following season. Neither is the possession of normal foliage by a plant a sure indication that its progeny will be normal. Degeneration may occur quite suddenly. This is one reason why "selected" seed and "certified" seed sometimes fail to give satisfaction.

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[1] Remainder of discussion quoted directly from Bulletin 422, by F. C. Stewart.

"*Second:* It is unsafe to select seed potatoes from fields in which the plants are very uneven in size. The small plants in such fields are usually degenerates and their appearance in large numbers is an indication that the strain is in the process of degeneration. Even the normal plants in such fields may produce worthless progeny, as happened with Green Mountain Jr., and some other varieties in our experiments.

"*Third:* The mosaic disease threatens to become an important factor in the production of seed potatoes. It is very common in the seed-potato fields of Maine and northern New York. Long Island buyers of northern-grown seed suffer heavy losses from it. Through experiments [of another investigator] and observations recorded in this bulletin, it has been established that mosaic is transmitted through the seed tubers. Hence, it is important that all severely-affected plants, at least, be eliminated from seed-potato fields. It is not yet clear as to what may be expected of the progeny of plants slightly affected with mosaic. If, as now seems probable, tubers of slightly-affected plants are liable to produce worthless mosaic dwarfs, it will become necessary to make very strict rules regarding mosaic in the inspection of certified seed potatoes. Unfortunately, mild cases of mosaic are frequently difficult of detection.

"*Fourth:* It is often stated that potatoes will not 'run out' if rigorous seed selection is practiced. The writer's experiences with the degenerate strains herein described lead him to question the accuracy of this statement. It seems impossible that the degeneration of the Green Mountain and Pride of Vermont described on pages [3 and 6] could have been prevented by any method of seed selection. It is our opinion that, under certain conditions, potatoes will 'run out' in spite of anything which can be done."

[Plates VII and VIII were used to illustrate this edition.]

SOME NEW OR RARE FRUIT PESTS.*

F. H. HALL.

Minor pests sometimes destructive. Such pests as San José scale, codling moth, pear psylla and plum curculio will probably always receive most attention from both fruit growers and economic entomologists; for they are ever present and liable at any time to do serious damage to fruit crops. Other species occasionally become prominent and for a season or two may be so very numerous and destructive that their presence overshadows the work of the more common insects, as during outbreaks of army worm or tent-caterpillars. Still other species come from abroad and gradually develop until they become major pests, others feed ordinarily upon plants of no economic importance but occasionally make inroads upon orchards or berry patches to the great detriment to their owners, and still others are so restricted to isolated localities that they seldom come to public notice. It is to these last classes of pests that this bulletin refers, and the investigations relative to them have been incidental rather than carefully planned and are, therefore, less complete than those relating to the major fruit insects.

An immigrant to be feared. Several years ago it was found that orchard ermine moths were being introduced into this State from Europe in their nests on nursery stock. These pests had been unknown in this country, at least in any but isolated cases, previous to this time; but in their native homes they are so destructive and they were found in such numbers on the foreign nursery stock that the situation was quite alarming. The attention of State and Government inspectors was called to the danger, and foreign authorities were warned not to allow infested stock to be shipped. The measures adopted seemed quite effective for a few years, as comparatively few insects or nests were found in 1912 or 1913. During 1914 and 1915, however, large numbers of the insects have entered the country; since the inspectors of the State Department of Agriculture found, during 1915, more than 3,000 seedlings

* A reprint of " Popular Edition " of Bulletin No. 423; for regular edition see p. 424.

infested with ermine moth nests in more than a dozen localities widely distributed in the fruit regions of western New York. The danger of permanent establishment of these pests is apparently great, and fruit growers should be on the alert to recognize and combat them on their first appearance.

Life history of ermine moth.

The tiny caterpillars hatch during late summer or early fall, but remain inactive during the fall and winter under the protecting crust of the egg mass, only emerging when the buds open in the spring. They hide among the green leaflets and immediately eat their way beneath the surface, entering usually at the edge, particularly near the leaf tips. The larvæ themselves can not be seen or reached by insecticides at this stage; but within two or three days after they have entered the leaves these turn reddish brown at tips or edges, the discolored areas increasing with the advance of the little miners. This stage of the insect lasts about two weeks, when they become too large to continue inside the leaf, so they establish themselves on the upper surface, protected by a light, transparent, grayish web, which is often attached to leaves above the ones on which the larvæ are working. This stage begins about at the conclusion of the blossoming period of the apple. Under the web the insects " skeletonize " the leaf, working here for about a week and then migrating to the tips of the highest branches, where gradually enlarging nests are formed by making webs about clusters of leaves. With increasing size the destructive power of the larvæ develops rapidly; so that large nests are formed by each colony and many leaves are completely eaten, leaving only the larger veins and the midrib. The larvæ mature during the latter part of June, change to pupæ, and these give place, in late June or early July, to the small white moths, beautifully marked with black dots, whose appearance gives them the name " ermine " moths.

Spraying will kill larvæ.

To control these insects in orchards should not be especially difficult, since they succumb readily to spraying with arsenicals. The time when they can be successfully reached, however, is rather short, as they are inactive for most of the year and spend part of their period of activity within the leaf, where sprays do not affect them. From the time when they begin to " skeletonize " the leaves, about June 1, their presence is readily noted and they are quite susceptible to poison sprays.

A leaf weevil on the peach.

An insect of which little is really known, except that it is quite widely distributed, especially in the Mississippi Valley states, and in Ontario, has several times been found attacking peach trees, particularly those newly planted, in Niagara County. This is the peach leaf-weevil, a snout beetle like the plum curculio, which eats into the opening leaf buds, destroying or severely injuring the leaf-

clusters, and later eats small semi-circular areas along the margins of the tender leaves. They appear early in May and disappear in late July, but are revealed more by their work than by the presence of the insects themselves since they feed mostly at night, hiding during the day in folds of the leaves, under lumps of earth about the base of the tree, or partly buried in the soil.

Damage from them is not usually great, but they prefer small, young trees, and may, through this preference, sometimes collect on such trees in sufficient numbers to interfere with their growth at a critical time.

They can be kept from such small trees by a cover of netting, and may also be collected on sheets by jarring the trees as was formerly advised for the plum curculio. It is probable, also, that they can be controlled by spraying with arsenicals, since they feed on the foliage; but care must be used in treating peach foliage with such remedies, since the peach is very susceptible to arsenic injury. The use, in an experimental way, of two pounds only of arsenate of lead, with two pounds of lump lime to fifty gallons of water is recommended.

Widely distributed, rarely harmful.

The common peach borer is well known to all growers of that fruit; and many are the back-aches incurred in digging out this concealed enemy. Another borer also attacks peach and plum trees, but is commonly found only in neglected orchards where the presence of one more pest is of slight consequence. However, a few quite severe cases of infestation by the insect, in orchards that were being cared for though previously neglected, have brought its work before the Station entomologists.

The insect apparently does not attack trees at smooth, healthy places on the bark, but may enter not only at the collar, which is the principal scene of operations of the larger borer, but particularly at the crotch and at any other roughened, cracked spot in the bark on trunk, branches or even small twigs.

In the smaller twigs the channels made by the borers are concealed beneath the outer layer of the bark, their presence being indicated only by excrement and gum at the entrances to the tunnels. In larger branches the bark is roughened, split, marked by exit holes of the pupæ and by unsightly collections of excrement and gum. Often the larvæ are sufficiently numerous and the channels so many and so deep that the trunk or branch is practically girdled.

The eggs, as reported by others, are small, compressed, elliptical-oval bodies, similar to the eggs of the common peach borer, and are laid singly or in clusters, to the number of two or three hundred, in crevices or openings of the bark or under loosened bark in any part of the tree.

Egg-laying probably extends well through June and July, as observations made on June 20 showed that about 30 per ct. of the

adults had emerged, 30 per ct. were in the pupa stage, and the remaining larvæ were practically full grown. The eggs hatch in about 10 days and the larvæ live in the channels until pupation early the following summer. Pupation takes place in cocoons of sawdust and excrement firmly held together by silk. The cocoon is usually slightly reddish, like the bark it is on, and is often placed in a partially excavated pit or chamber under a loosened piece of bark near the exit from the larval tunnel.

The adults are clear-winged moths, like the male of the common peach borer, bluish-black in color with circles of yellowish-black scales about the eyes and with pale yellow bands on the second and fourth segments of the body. The moths might easily be mistaken for certain species of wasps.

The only reliable method of disposing of these borers is to dig them out, as is done with the common peach borer, in the fall, winter or early spring. Old or weakened trees should be removed and the others carefully pruned, burning all dead or borer-injured wood.

A forest pest in the orchard.

A most peculiar insect, in that it matures late in the fall when most other insect activities are suspended, is the lime-tree winter moth. This is ordinarily a forest pest, and of slight economic importance, but in 1912 the caterpillars became very numerous in certain parts of western New York. Many of them left their forest feeding grounds and attacked adjacent apple and cherry orchards and trees of these fruits along the roadsides. In the forests the trees principally affected were linden (lime) and elm, but a few larvæ were found on maple, hickory, ash and oak trees. The feeding of the caterpillars on the foliage produces a peculiar raggedness of the leaves, as though they had been riddled by shot.

The larvæ are characteristic canker worms or loopers, and often feign death by holding their bodies rigid or suspending themselves by the rear feet. The larvæ appeared to be nearly mature on June 8 when first noticed in an apple orchard, but many were still present ten days later, though some had already pupated and nearly all did so within the next week. The pupæ are found at or near the surface of the ground under leaves and rubbish, or buried as deep as three inches in the soil.

As noted above, the adults emerge very late in the season — from October 21 to November 4 in 1912, and females were ovipositing a week after this time. They can evidently stand temperatures only slightly above freezing. The adults are active only late in the day and in the evening. The females lay large numbers of eggs, probably more than 500.

The male moths are quite large, having a wing spread of an inch and three-quarters, but these are of an inconspicuous rusty buff color without striking marks, though quite widely variant in shading.

The females are wingless, dark to light brown, or ash gray in color and therefore easily escape notice unless specially sought.

The inability of the females to fly and their emergence well toward winter when the eggs are subject to severe weather are factors that seem to preclude any great liability to danger from the species; and any outbreak of them, if taken in time, could easily be controlled by spraying. Caterpillars of these moths have not been found in any well sprayed orchards.

Currant fruits infested. A not uncommon insect enemy of the gooseberry is a fruit worm, which occasionally does considerable damage in plantations of this fruit. But the relatively small importance of the gooseberry in America has allowed the insect to escape without much study. The attention of the Station was called to it several years ago, however, when it was reported as having destroyed practically the whole crop of currants in a plantation near White Plains for several years in succession.

Life history and habits. The adult female deposits her eggs on the young gooseberries a short time after the fruit is set. The young larvæ soon appear and bore into the berry. On April 21 at White Plains, N. Y., no trace of an infestation could be found. During the second week in May occasional berries were being drawn together by a delicate silken thread which that year was the earliest evidence of the insect in this planting. About the last week in May the caterpillars left the berries first attacked and webbed together other fruit of the cluster. As the creatures became larger in size several berry clusters were usually drawn together and formed a nest in which the caterpillars remained concealed. When disturbed the larvæ quickly left the berries or the nest and lowered themselves to the ground with the aid of a slender thread. By June 7 the caterpillars were mature, and on June 28 few of the creatures were to be found. On the latter date many delicate, finely-woven cocoons were found among the injured currant clusters or fallen leaves and other debris on the ground beneath the bushes. Specimens of these cocoons and others obtained from larvæ bred in the laboratory were placed in cages where they remained until the following spring when the moths emerged. The adults appeared during the last week in April.

Control methods found of value were the use of poison sprays, no difference in effectiveness being noticed between arsenate of lead or paris green in bordeaux mixture. Caustic soda solution and lime sulphur solution appeared to have little repressive effect.

Injurious species in new group. Larvæ of a green fruit worm were carried to maturity, when, to the surprise of all, they proved to be of a species never reported as injurious in a group which contains no other harmful insects.

[Plates LV and LVII were used to illustrate this edition.]

PERIODICALS RECEIVED BY THE STATION.

Acclimitation	Complimentary
Agricultural Epitomist	Complimentary
Agricultural Gazette of Canada	Complimentary
Agricultural Gazette of New South Wales	Complimentary
Agricultural Journal, China	Complimentary
Agricultural Journal of the Union of South Africa	Complimentary
Agricultural News	Complimentary
Agricultural Review [formerly Dry Farming]	Subscription
Agricultural Students' Gazette	Complimentary
Allegan Gazette	Complimentary
American Agriculturist	Subscription
American Chemical Society Journal	Subscription
American Cultivator	Complimentary
American Entomological Society, Transactions	Subscription
American Fertilizer	Subscription
American Florist	Subscription
American Food Journal	Complimentary
American Grocer	Complimentary
American Hay, Flour and Feed Journal	Complimentary
American Journal of Botany	Subscription
American Journal of Physiology	Subscription
American Miller	Complimentary
American Naturalist	Subscription
American Philosophical Society, Proceedings	Complimentary
American Poultry Advocate	Complimentary
American Society of Agronomy	Subscription
Analyst	Subscription
Annales de l'Institut Pasteur	Subscription
Annales de la Societe Entomologique de Belgique	Complimentary
Annales Mycologici	Subscription
Annals and Magazine of Natural History	Subscription
Annals of Applied Biology	Subscription
Annals of Botany	Subscription
Annals of the Missouri Botanical Garden	Subscription
Archiv der Gesammte Physiologie (Pflueger)	Subscription
Archiv fuer Hygiene	Subscription
Association belge des Chimistes, Bulletin	Complimentary
Berichte der deutschen botanischen Gessellschaft	Subscription
Berichte der deutschen chemischen Gessellschaft	Subscription
Better Fruit	Complimentary
Bibliographia Zoologica	Subscription
Biedermann's Zentralblatt fuer Agrikultur Chemie	Subscription

Biochemical Bulletin	Complimentary
Biochemische Zeitschrift	Subscription
Biological Bulletin	Subscription
Biologisches Centralblatt	Subscription
Blooded Stock	Complimentary
Boletim de Agricultura	Complimentary
Boletim do Instituto Agronomico	Complimentary
Boletin de la Sociedad Nacional de Agricultura	Complimentary
Boston Society of Natural History, Proceedings	Complimentary
Botanical Gazette	Subscription
Botanisches Centralblatt	Subscription
Bulletin de l'Institut Pasteur	Subscription
Bulletin fuer angewandte Botanik	Complimentary
California Academy of Sciences, Proceedings	Complimentary
California Cultivator	Complimentary
California Fruit News	Subscription
California University Publications — Agricultural Sciences, Botany and Zoology	Complimentary
Canadian Entomologist	Subscription
Canadian Horticulturist	Complimentary
Centralblatt fuer Bakteriologie, etc	Subscription
Chemical Abstracts	Subscription
Chemical Society, Journal	Subscription
Chemisches Centralblatt	Subscription
Chicago Daily Farmers' and Drovers' Journal	Complimentary
Chicago Dairy Produce	Complimentary
Cold	Complimentary
Cold Storage and Ice Trades Review	Complimentary
Colonial Dairy Produce Report	Complimentary
Columbus Horticultural Society Journal	Complimentary
Commercial Fertilizer	Complimentary
Commercial Poultry	Complimentary
Country Gentleman	Subscription
Country Life in America	Subscription
Country World	Complimentary
Creamery and Milk Plant Monthly	Complimentary
Criador Paulista	Complimentary
Dairy and Produce Review	Complimentary
Denver Field and Farm	Complimentary
Deutsche Entomologische Zeitschrift	Complimentary
Deutschlands Obstsorten	Subscription
Duroc Bulletin	Complimentary
Elgin Dairy Report	Complimentary
Entomological News	Subscription
Entomological Society of America, Annals	Subscription
Entomological Society of Washington, Proceedings	Subscription
Entomologische Mitteilungen	Complimentary

Entomologist	Subscription
Entomologists' Record	Subscription
Facts About Sugar	Complimentary
Farm and Fireside	Complimentary
Farm and Live Stock Journal	Complimentary
Farm and Orchard	Complimentary
Farm and Stock	Complimentary
Farm Engineering	Complimentary
Farm Journal	Complimentary
Farm Life	Complimentary
Farm News	Complimentary
Farm Poultry	Complimentary
Farm, Stock and Home	Complimentary
Farm Stock Success	Complimentary
Farmers' Advocate	Complimentary
Farmers' Digest	Complimentary
Farmers' Guide	Complimentary
Farmers' Voice	Complimentary
Farmer's Wife	Complimentary
Feathered World	Subscription
Field, The, Illustrated	Complimentary
Florists' Exchange	Subscription
Flour and Feed	Complimentary
Fruit Grower	Complimentary
Fruit and Produce Marketer	Complimentary
Garden	Subscription
Gardeners' Chronicle	Subscription
Gartenwelt	Subs ription
Gas and Oil Power	Complimentary
Gas Power	Complimentary
Gleanings in Bee Culture	Complimentary
Grape Belt, The	Complimentary
Green's Fruit Grower	Complimentary
Guide to Nature	Subscription
Hartwick Seminary Monthly	Complimentary
Harvester World	Complimentary
Hawaiian Forester and Agriculturist	Complimentary
Herd Register	Complimentary
Herkimer County News	Complimentary
Hoard's Dairyman	Complimentary
Holstein-Friesian Register	Complimentary
Holstein-Friesian World	Complimentary
Homestead	Complimentary
Hospodar	Complimentary
Hygienische Rundschau	Subscription
Indiana Farmer	Complimentary
Insect World (Japanese)	Complimentary

Internationale Mitteilungen fuer Bodenkunde	Subscription
Jahresbericht der Agrikultur-Chemie	Subscription
Jahresbericht Garungs-Organismen	Subscription
Jahresbericht der Nahrungs- und Genussmittel	Subscription
Jahresbericht Pflanzenkrankheiten	Subscription
Jahresbericht der Tier-Chemie	Subscription
Jahresheft Schlesische Insektenkunde	Complimentary
Journal fuer Landwirtschaft	Subscription
Journal of Agricultural Research	Complimentary
Journal of Agricultural Science	Subscription
Journal of Agriculture, Victoria	Complimentary
Journal of Agriculture, with Colman's Rural World	Complimentary
Journal of American Medical Association	Subscription
Journal of Association of Official Agricultural Chemists	Subscription
Journal of Biological Chemistry	Subscription
Journal of Board of Agriculture (English)	Complimentary
Journal of the College of Agriculture, Tokyo	Complimentary
Journal of the Department of Agriculture of South Australia	Complimentary
Journal of the Department of Agriculture of Victoria	Complimentary
Journal of the New Zealand Department of Agriculture	Complimentary
Journal of Economic Biology	Subscription
Journal of Experimental Medicine	Subscription
Journal of Experimental Zoology	Subscription
Journal of Genetics	Subscription
Journal of Heredity	Subscription
Journal of Home Economics	Subscription
Journal of Hygiene	Subscription
Journal of Industrial and Engineering Chemistry	Subscription
Journal of Pathology and Bacteriology	Subscription
Journal of Physiology	Subscription
Just's Botanischer Jahresbericht	Subscription
Kimball's Dairy Farmer	Complimentary
Konigleichen Bayerische Akademie der Wissenschaften: Sitzungsberichte der Math.— Phys. Classe	Subscription
Land, The	Complimentary
Lanswirtschaft-Historische Blätter	Complimentary
Landwirtschaftliche Jahrbucher	Subscription
Landwirtschaftlichen Versuchs-Stationen	Subscription
Live Stock and Dairy Journal	Complimentary
Live Stock Report	Complimentary
Maandblad der Nederlandsche Pomologische Veeriniging	Complimentary
Market Growers' Journal	Complimentary
Memoirs of the Department of Agriculture in India	Complimentary
Metropolitan and Rural Home	Complimentary
Michigan Farmer	Complimentary
Milchwirtschaftliches Zentralblatt	Subscription
Minnesota and Dakota Farmer	Complimentary

Mirror and Farmer	Complimentary
Modern Farming	Complimentary
Monthly Bulletin, International Institute of Agriculture	Complimentary
Monthly Bulletin of the N. Y. State Department of Health	Complimentary
Monthly Weather Review	Complimentary
Mycologia	Subscription
National Nurseryman	Complimentary
National Farmer (German)	Complimentary
National Farmer and Stock Grower	Complimentary
National Stockman and Farmer	Complimentary
Naturaliste Canadienne	Complimentary
Nebraska Farmer	Complimentary
New York Academy of Science, Annals and Transactions	Subscription
New York Botanical Garden, Bulletin	Complimentary
New York Entomological Society, Journal	Subscription
New York Farmer	Complimentary
New York Fruit and Produce News	Complimentary
New Zealand Dairyman	Complimentary
North American Horticulturist	Complimentary
North Fort Worth Sunday News	Complimentary
Northwest Pacific Farmer	Complimentary
Nut Grower	Complimentary
Ohio Farmer	Complimentary
Ohio Journal of Science	Subscription
Oklahoma Farm Journal	Complimentary
Pacific Coast Fanciers' Monthly	Subscription
Pacific Northwest	Complimentary
Pacific Fruit World	Complimentary
Parasitology	Subscription
Pennsylvania Farmer	Complimentary
Photo-Miniature	Subscription
Physiological Researches	Subscription
Phytopathology	Subscription
Popular Agriculturist (Chinese)	Complimentary
Poultry	Complimentary
Poultry Herald	Subscription
Poultry Item	Complimentary
Poultry Keeper	Complimentary
Poultry Monthly	Complimentary
Power and Engineer	Subscription
Practical Farmer	Complimentary
Praktische Blaetter	Subscription
Profitable Breeding and Farming	Complimentary
Progressive Farmer	Complimentary
Profitable Farming	Complimentary
Psyche	Subscription
Quarterly Journal	Complimentary

Recreation	Subscription
Rabenhorst's Kryptogamen-Flora	Subscription
Reclamation Record	Complimentary
Reliable Poultry Journal	Subscription
Review of Applied Entomology	Subscription
Revista Industrial y Agricola de Tucuman	Complimentary
Revue de Viticulture (For Vineyard Laboratory, Fredonia, N. Y.)	Subscription
Revue Generale de Botanique	Subscription
Revue Horticole	Subscription
Rhode Island Red Journal	Complimentary
Riqueza Agricola	Complimentary
Royal Agricultural Society Journal	Subscription
Royal Botanic Gardens, Edinburgh, Notes	Complimentary
Royal Horticultural Society Journal	Complimentary
Rural Life	Complimentary
Rural New Yorker	Subscription
Salt Lake Herald	Complimentary
Salt Louis Academy of Science, Transactions	Complimentary
Sanitary Inspector	Complimentary
Science	Subscription
Scientific American	Subscription
Scientific Roll, Bacteria	Subscription
Seed World	Complimentary
Skaneateles Democrat	Complimentary
Smallholder, The	Complimentary
Societe Entomologique Belgique, Annales	Complimentary
Societe Entomolgique de France, Bulletin	Complimentary
Societe Mycologique de France, Bulletin	Subscription
Soil Science	Subscription
Southern Planter	Complimentary
Southern Farm Magazine	Complimentary
Southwest Trail	Complimentary
Southwestern Farmer and American Horticulturist	Complimentary
Southwestern Farmer and Breeder	Complimentary
Southwestern Stockman, Farmer and Feeder	Complimentary
Stazione Sperimentale Agrarie Italiane	Complimentary
Student Farmer, The	Complimentary
Successful Farming	Complimentary
Suffolk Herald	Complimentary
Texas Stockman and Farmer	Complimentary
Torrey Botanical Club, Bulletins and Memoirs	Subscription
Transvaal Agricultural Journal	Complimentary
Trucker and Farmer	Complimentary
Utica Semi-Weekly Press	Complimentary
Vertical Farming	Complimentary
Wallace's Farmer	Complimentary
West Virginia Farm Review	Complimentary

Western Fruit-Grower	**Complimentary**
Western Plowman	**Complimentary**
Wilson Bulletin	**Complimentary**
Wisconsin Natural History Society, Bulletin	**Complimentary**
Zeitschrift fuer Analytische Chemie	**Subscription**
Zeitschrift fuer Biologie	**Subscription**
Zeitschrift fuer Botanik	**Subscription**
Zeitschrift für Fleisch- und Milch-Hygiene	**Subscription**
Zeitschrift fuer Hygiene und Infektionskrankheiten	**Subscription**
Zeitschrift fuer Induktive Abstammungs- und Vererbungslehre	**Subscription**
Zeitschrift fuer Pflanzenkrankheiten	**Subscription**
Zeitschrift fuer Pflanzenzuchtung	**Subscriotion**
Zeitschrift fuer Physiologische Chemie	**Subscription**
Zeitschrift für Untersuchung der Nahrungs- und Genussmittel	**Subscription**
Zeitschrift fuer Wissenschaftliche Insektenbiologie	**Subscription**
Zentralblatt fuer Biochemie und Biophysik	**Subscription**
Zoological Record	**Subscription**
Zoologischer Anzeiger	**Subscription**

METEOROLOGICAL RECORDS FOR 1916.

Reading of the Standard Air Thermometer.

DATE.	January.			February.			March.			April.			May.			June.		
	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.
1	35.	36.	36.	35.	37.	29.	9.	25.	22.	48.	57.	53.	53.	72.	75.	56.	68.	70.
2	35.	40.	37.	21.	21.	20.	13.	25.	18.	37.	38.	45.	40.	51.	56.	58.	75.	73.
3	30.	31.	26.	20.	20.	18.	9.	23.	20.	31.	45.	40.	45.	50.	64.	63.	64.	57.
4	29.	28.	35.	12.	23.	25.	14.	19.	16.	37.	39.	40.	42.	57.	63.	65.	71.	78.
5	43.	45.	47.	23.	28.	33.	20.	19.	17.	40.	47.	47.	56.	69.	62.	65.	70.	60.
6	20.	20.	20.	31.	33.	30.	13.	19.	20.	37.	44.	40.	52.	66.	68.	58.	69.	69.
7	18.	22.	18.	24.	12.	16.	39.	44.	42.	30.	39.	39.	60.	71.	68.	60.	66.	58.
8	4.	19.	18.	11.	20.	17.	31.	34.	26.	30.	38.	35.	52.	65.	70.	56.	62.	66.
9	14.	28.	31.	24.	30.	27.	11.	22.	22.	32.	35.	41.	47.	53.	54.	56.	64.	66.
10	30.	33.	37.	19.	22.	21.	30.	24.	23.	34.	45.	46.	47.	54.	60.	56.	60.	66.
11	30.	31.	28.	11.	17.	19.	12.	24.	23.	42.	56.	51.	58.	66.	65.	57.	63.	58.
12	24.	31.	35.	17.	18.	16.	17.	31.	31.	41.	46.	50.	45.	54.	57.	60.	67.	72.
13	40.	31.	28.	11.	12.	10.	32.	34.	32.	41.	43.	45.	50.	62.	60.	62.	72.	77.
14	10.	7.	5.	—3.	7.	6.	26.	26.	20.	44.	44.	35.	52.	58.	55.	64.	77.	75.
15	8.	20.	17.	2.	22.	24.	13.	13.	11.	40.	51.	54.	50.	62.	76.	60.	60.	57.
16	28.	28.	22.	25.	31.	34.	6.	20.	20.	43.	63.	64.	67.	73.	66.	55.	60.	65.
17	—2.	12.	13.	34.	36.	36.	13.	11.	7.	52.	52.	52.	49.	51.	47.	64.	73.	75.
18	11.	17.	14.	27.	35.	24.	....	15.	16.	39.	44.	48.	42.	45.	49.	69.	73.	64.
19	12.	18.	17.	4.	9.	9.	18.	28.	24.	40.	53.	52.	50.	59.	65.	57.	62.	57.
20	24.	31.	36.	10.	17.	15.	11.	29.	29.	43.	53.	64.	49.	59.	57.	49.	51.	57.
21	38.	48.	49.	—5.	5.	9.	25.	37.	34.	53.	68.	57.	58.	65.	64.	54.	54.	61.
22	54.	53.	42.	19.	37.	40.	28.	26.	19.	54.	46.	45.	52.	52.	53.	55.	67.	67.
23	27.	29.	31.	31.	29.	27.	17.	14.	23.	41.	42.	42.	55.	68.	71.	55.	67.	63.
24	28.	43.	42.	14.	29.	31.	11.	81.	32.	44.	53.	52.	56.	80.	80.	57.	73.	78.
25	37.	48.	44.	32.	33.	31.	33.	47.	44.	46.	56.	55.	65.	74.	72.	67.	71.	72.
26	40.	52.	53.	22.	24.	24.	39.	49.	49.	48.	58.	59.	58.	66.	69.	65.	73.	77.
27	49.	58.	60.	11.	13.	16.	41.	43.	40.	47.	46.	51.	55.	65.	69.	68.	78.	73.
28	46.	40.	26.	9.	12.	16.	39.	49.	46.	50.	52.	61.	62.	78.	75.	62.	72.	72.
29	17.	24.	28.	12.	26.	24.	38.	45.	45.	62.	65.	70.	69.	77.	73.	62.	67.	72.
30	35.	38.	39.	....	....	....	39.	50.	51.	52.	70.	68.	66.	58.	66.	67.	77.	75.
31	44.	55.	58.	....	....	....	34.	53.	56.	....	....	....	54.	58.	64.	....	....	....
Averages	27.7	32.8	32.0	17.4	22.7	22.3	22.0	29.9	28.3	42.6	49.6	50.0	53.4	62.5	64.3	60.1	67.5	67.7

READING OF THE STANDARD AIR THERMOMETER (*concluded*).

DATE.	July.			August.			September.			October.			November.			December.		
	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.
1	66.	79.	79.	64.	74.	75.	66.	85.	77.	44.	45.	56.	46.	53.	47.	32.	40.	45.
2	67.	83.	76.	63.	78.	83.	60.	67.	72.	40.	66.	66.	40.	57.	52.	37.	42.	37.
3	65.	71.	68.	68.	81.	79.	50.	68.	68.	40.	65.	67.	38.	45.	42.	28.	39.	40.
4	64.	75.	69.	71.	86.	92.	56.	83.	87.	47.	72.	72.	39.	45.	43.	43.	47.	48.
5	64.	74.	76.	73.	82.	84.	66.	80.	79.	54.	74.	76.	38.	40.	40.	49.	58.	47.
6	69.	83.	83.	74.	83.	83.	67.	85.	83.	57.	67.	67.	39.	45.	46.	36.	42.	40.
7	71.	86.	88.	74.	90.	95.	71.	85.	80.	44.	64.	65.	40.	55.	54.	30.	37.	35.
8	72.	81.	75.	79.	83.	83.	70.	71.	68.	54.	85.	81.	45.	61.	57.	40.	51.	50.
9	65.	75.	75.	65.	74.	79.	60.	72.	71.	65.	51.	54.	50.	67.	58.	39.	39.	31.
10	66.	78.	81.	66.	76.	77.	62.	71.	73.	32.	50.	50.	42.	52.	46.	27.	32.	28.
11	71.	85.	89.	65.	72.	72.	54.	74.	73.	44.	58.	57.	39.	42.	36.	28.	32.	38.
12	79.	91.	93.	65.	76.	78.	57.	71.	76.	40.	61.	64.	29.	43.	37.	33.	34.	26.
13	78.	80.	80.	54.	67.	68.	57.	82.	83.	53.	55.	54.	33.	33.	33.	15.	29.	24.
14	68.	80.	83.	58.	70.	75.	57.	80.	78.	49.	51.	54.	28.	31.	28.	21.	23.	22.
15	74.	81.	81.	62.	76.	81.	62.	68.	60.	44.	65.	58.	23.	33.	25.	18.	21.	20.
16	75.	86.	81.	60.	77.	84.	49.	58.	57.	51.	53.	59.	25.	28.	27.	12.	18.	18.
17	70.	79.	83.	64.	83.	87.	49.	67.	69.	44.	45.	42.	26.	32.	33.	13.	21.	11.
18	76.	83.	85.	64.	81.	85.	48.	63.	54.	34.	48.	47.	24.	36.	36.	7.	25.	14.
19	73.	83.	84.	67.	89.	90.	42.	58.	61.	45.	52.	58.	30.	43.	37.	15.	18.	16.
20	74.	87.	89.	70.	90.	92.	55.	73.	74.	57.	65.	67.	36.	38.	32.	18.	27.	28.
21	75.	89.	73.	76.	93.	95.	56.	74.	71.	44.	49.	47.	21.	30.	27.	33.	37.	37.
22	73.	87.	88.	73.	95.	99.	56.	66.	58.	42.	51.	45.	23.	45.	35.	32.	34.	23.
23	76.	88.	90.	67.	66.	67.	57.	63.	62.	34.	52.	52.	40.	44.	52.	18.	24.	21.
24	76.	91.	93.	57.	74.	79.	50.	59.	54.	40.	55.	49.	42.	38.	33.	18.	24.	26.
25	76.	84.	81.	63.	76.	78.	48.	61.	56.	44.	59.	59.	18.	27.	25.	27.	24.	23.
26	74.	88.	92.	64.	83.	78.	46.	67.	67.	42.	45.	43.	20.	24.	30.	10.	19.	17.
27	73.	83.	84.	65.	58.	65.	64.	81.	79.	31.	46.	51.	42.	52.	43.	31.	34.	37.
28	67.	82.	85.	56.	74.	71.	64.	74.	72.	38.	48.	49.	44.	48.	47.	34.	23.	21.
29	69.	83.	88.	53.	72.	78.	52.	56.	54.	42.	59.	54.	47.	54.	53.	17.	21.	14.
30	75.	93.	93.	59.	82.	76.	40.	47.	45.	50.	65.	58.	40.	44.	37.	16.	21.	19.
31	83.	86.	84.	57.	78.	82.	....	....	....	46.	49.	54.	....	....	....	14.	23.	21.
Averages	71.8	83.0	82.9	65.0	78.7	81.0	56.4	70.3	68.7	44.9	57.1	57.3	34.9	42.8	39.7	25.5	30.9	28.3

READING OF MAXIMUM AND MINIMUM THERMOMETERS FOR 1916.

DATE.	JANUARY.		FEBRUARY.		MARCH.		APRIL.		MAY.		JUNE.	
	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.
1	38.	15.	47.	28.	29.	9.	60.	41.	80.	50.	73.	41.
2	49.	34.	30.	19.	26.	11.	53.	37.	75.	39.	78.	49.
3	38.	25.	22.	12.	25.	8.	50.	29.	64.	39.	74.	47.
4	35.	23.	26.	10.	20.	11.	40.	35.	64.	40.	78.	49.
5	48.	35.	33.	19.	25.	15.	50.	34.	71.	45.	71.	44.
6	51.	17.	36.	30.	20.	10.	47.	30.	72.	45.	70.	51.
7	24.	15.	30.	11.	48.	19.	43.	28.	72.	52.	69.	55.
8	20.	4.	23.	10.	43.	25.	39.	26.	75.	43.	68.	54.
9	32.	7.	30.	16.	26.	10.	44.	31.	70.	45.	67.	53.
10	38.	7.	27.	16.	34.	17.	48.	29.	61.	37.	67.	52.
11	46.	27.	22.	10.	27.	11.	59.	30.	75.	48.	69.	54.
12	35.	21.	19.	15.	32.	12.	53.	40.	66.	40.	73.	52.
13	44.	27.	20.	8.	37.	30.	50.	40.	67.	39.	78.	55.
14	28.	4.	12.	—3.	33.	20.	52.	34.	66.	40.	78.	53.
15	21.	2.	25.	—8.	21.	11.	56.	34.	76.	47.	75.	56.
16	30.	17.	35.	23.	23.	4.	68.	35.	77.	58.	65.	54.
17	30.	—3.	38.	33.	21.	7.	64.	48.	67.	46.	76.	60.
18	18.	10.	36.	23.	17.	—3.	52.	37.	49.	40.	78.	57.
19	22.	9.	24.	3.	30.	15.	55.	32.	65.	37.	81.	51.
20	36.	14.	18.	6.	35.	11.	64.	40.	65.	44.	60.	47.
21	55.	24.	11.	—5.	39.	24.	73.	48.	68.	41.	62.	49.
22	55.	41.	43.	4.	35.	19.	57.	44.	65.	41.	68.	47.
23	42.	26.	41.	25.	26.	14.	45.	40.	72.	41.	70.	46.
24	50.	23.	32.	4.	36.	5.	53.	41.	82.	48.	79.	54.
25	49.	36.	34.	30.	49.	20.	59.	43.	80.	53.	81.	64.
26	56.	39.	30.	24.	54.	33.	64.	44.	72.	49.	78.	50.
27	61.	40.	20.	10.	50.	38.	59.	45.	69.	47.	82.	60.
28	60.	26.	17.	8.	52.	38.	62.	41.	82.	48.	76.	60.
29	29.	16.	28.	11.	50.	33.	70.	38.	77.	58.	74.	51.
30	39.	27.	......	......	52.	30.	72.	42.	73.	48.	79.	54.
31	58.	34.	......	......	58.	32.	......	......	67.	49.	......	......
Averages	39.9	20.7	27.8	13.5	34.6	17.4	55.4	37.2	70.5	45.1	73.2	52.3

READING OF MAXIMUM AND MINIMUM THERMOMETERS FOR 1916 (*concluded*).

DATE.	July.		August.		September.		October.		November.		December.	
	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.
1	82.	49.	85.	59.	85.	61.	62.	30.	56.	43.	46.	31.
2	84.	57.	84.	46.	77.	59.	72.	35.	61.	39.	46.	35.
3	79.	64.	84.	53.	72.	44.	70.	36.	53.	37.	41.	27.
4	74.	58.	93.	57.	88.	50.	80.	42.	49.	33.	48.	37.
5	77.	54.	92.	67.	82.	60.	83.	50.	43.	38.	62.	45.
6	84.	52.	86.	71.	89.	63.	71.	51.	47.	37.	47.	25.
7	89.	58.	97.	67.	93.	68.	72.	42.	59.	38.	40.	29.
8	88.	63.	95.	74.	81.	64.	87.	50.	74.	44.	52.	31.
9	78.	60.	84.	63.	73.	53.	70.	43.	71.	42.	56.	30.
10	82.	59.	81.	63.	75.	45.	54.	31.	58.	40.	33.	26.
11	90.	68.	77.	63.	77.	47.	62.	39.	50.	33.	40.	25.
12	94.	72.	79.	63.	79.	54.	67.	38.	47.	28.	34.	25.
13	93.	61.	78.	53.	85.	55.	64.	41.	37.	32.	30.	15.
14	84.	61.	77.	54.	84.	55.	54.	36.	34.	27.	25.	19.
15	84.	65.	82.	52.	78.	59.	66.	36.	34.	20.	25.	15.
16	89.	69.	85.	56.	60.	44.	60.	49.	31.	21.	20.	9.
17	85.	67.	90.	57.	73.	43.	65.	39.	34.	23.	24.	8.
18	88.	70.	89.	62.	69.	43.	49.	30.	38.	23.	28.	6.
19	87.	64.	94.	61.	64.	40.	59.	32.	47.	28.	22.	14.
20	90.	66.	93.	66.	78.	51.	70.	56.	39.	31.	32.	12.
21	89.	66.	98.	70.	76.	51.	68.	42.	33.	21.	40.	20.
22	92.	65.	101.	67.	71.	54.	52.	41.	49.	19.	37.	22.
23	94.	65.	99.	63.	68.	53.	56.	31.	52.	31.	25.	17.
24	95.	64.	80.	53.	62.	47.	58.	37.	52.	30.	27.	12.
25	93.	69.	80.	58.	62.	46.	63.	36.	33.	16.	37.	22.
26	93.	62.	84.	55.	68.	40.	60.	41.	34.	20.	24.	9.
27	92.	70.	78.	53.	81.	55.	52.	29.	54.	29.	37.	16.
28	86.	61.	72.	53.	79.	60.	55.	36.	49.	40.	38.	21.
29	89.	64.	79.	46.	62.	53.	61.	40.	55.	45.	21.	14.
30	96.	69.	83.	53.	54.	39.	72.	46.	55.	32.	22.	4.
31	93.	74.	83.	51.	......	......	58.	43.	......	......	26.	12.
Averages	87.5	63.4	85.9	59.0	74.8	51.9	64.3	39.7	47.6	31.3	35.0	20.6

SUMMARY OF AVERAGES OF MAXIMUM, MINIMUM AND STANDARD AIR THERMOMETERS FOR 1916.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum	39.9	27.8	34.6	55.4	70.5	73.2	87.5	85.9	74.8	64.3	47.6	35.0
Minimum	20.7	13.5	17.4	37.2	45.1	52.3	63.4	59.0	51.9	39.7	31.3	20.6
Standard 7 A. M	27.7	17.4	22.0	42.6	53.4	60.1	71.8	65.0	56.4	44.9	34.9	25.5
Standard 12 M	32.8	22.7	29.9	49.6	62.5	67.5	83.0	78.7	70.3	57.1	42.8	30.9
Standard 5 P. M	32.0	22.3	28.3	50.0	64.3	67.7	82.9	81.0	68.7	57.3	39.7	28.3

MONTHLY MAXIMUM AND MINIMUM TEMPERATURES FROM 1883 TO 1916 INCLUSIVE.
(Highest and Lowest Record for Each Month in Heavy Type.)

	January.				February.				March.				April.			
	MAX.		MIN.		MAX.		MIN.		MAX.		MIN.		MAX.		MIN.	
	Date.	Temp.	Date	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.
1883	18	44.	11	—9.	17	48.	24	—2.	19	61.	9	2.	16	75.	1	19.
1884	14	42.	26	—13.	7	55.	29	—3.	30	54.	1	—4.	28	74.	1	23.
1885	1	61.	29	—6.	10	38.	11	—11.5	28	48.	13	—11.	24	84.5	10	20.5
1886	5	52.5	13	—18.7	9	50.	27	—11.	16	58.	2	—2.5	24	80.5	4	22.
1887	24	50.7	19	—8.	9	54.2	27	—4.	3	51.7	1 & 5	8.7	11	75.7	1	17.2
1888	2	43.2	23	—6.	21	49.	10	—7.	28	57.	13	0.	29	82.5	8	19.
1889	18	55.	20	5.	23	42.	4 & 24	—7.	28	61.8	30	18.5	20	84.	1	26.
1890	6	67.	29	9.	5	64.5	11&21	9.5	13	62.	8	2.	13	78.8	1& 19	23.
1891	3	46.	17	4.	26	56.8	15	2.5	12	57.	2	4.5	28	81.4	7	21.
1892	3	48.	10	—5.	15	44.	6	2.8	27	52.2	4	6.	6	78.	17	25.5
1893	29	46.	11	—6.	15	47.4	5	—1.	24	54.	5	9.	13	75.3	26.2	25.
1894	5	59.	13	11.	20	47.6	27	—8.5	18	73.	26	15.	21	71.3	2	20.
1895*	7	45.	19	4.	25	46.	8	—14.	25	52.	5 & 16	12.	30	80.	3	28.
1896	30	44.	6	—16.5	29	49.	17	—21.	31	56.5	24	—2	17	87.	4& 5	19.
1897	5	58.	20	—3.5	18	49.5	1 & 27	5.5	21	64.	1	—1.	26	82.	20	19.
1898	13	57.	30&31	—4.	12	56.5	2 & 3	—2.	11	†65.	2	17.5	14&18	69.	69	18.
1899	5	59.	12	—4.	21	52.5	11	—8.	73	63.	21	13.	30	82.	3	23.
1900	23	56.	1	2.	14	57.	27	0.	10	46.	12	—3.	30	‡73.5	9	22.
1901	16	48.	20	—2.	16	36.	24	—2.5	24	67.	6	—1.	28	78.	12	28.
1902	3	44.	28	2.	28	52.	6	—3.	12	66.5	19	14.	22	87.	5	25.
1903	3	48.	9	—2.	28	62.5	18	—4	19	78.5	1 & 2	19.	30	86.	5	21.
1904	23	48.	19	—14.	7	58.	16	18.	26	58.	4	8.	24	67.5	14	16.
1905	1	49.	26	—2.	20	45.	5 & 14	—6.	29	82.	5	1.	27&28	75.	16	23.
1906	21	71.	9	4.	24	64.	6 & 7	—7.	27	51.	25	2.	19	74.	2	25.
1907	6	53.	24	—18.	2	47.	12	—4.	29	83.	7	—1.	29	73.	2	19.
1908	22	45.	31	—9.	15	53.	2 & 5	—14.	28	73.	1	8.	27	78.	4	18.
1909	24	64.	19	—7.	5	52.	1	—1.	10	52.	5	5.	19	75.	11	12.
1910	2 & 22	45.	5	—8.	16	29.	7	—3.	24	82.	14&18	17.	4	84.	7	27.
1911	27&30	48.	5	—1.	17	52.	22	4.	27	60.	16	—1.	29	80.	3	18.
1912	18	44.	14	—12.	24	48.	10	—10.	31	62.	4	—1.	6	78.	4	19.
1913	17	57.	13	8.	20	65.	10	—10.	14&15	69.	7 & 8	1.	24	84.	20	24.
1914	29	51.	13&14	—9.	3	52.	13&24	—14.	26	65.	12	7.	19	82.	9 & 13	22.
1915	7	46.	30	—3.	21&23	53.	10	10.	25	50.	1	11.	25&26	88.	5	23.
1916	27	61.	17	—3.	1	47.	15	—8.	31	58.	18	—3.	21	73.	8	26.

* Data from record kept by Mr. Edgar Parker for the year 1895; Station record not available.
† Maximum for first eleven days only. Record incomplete.
‡ Thermometers broken. Record not taken from April 19th to 24th inclusive.

MONTHLY MAXIMUM AND MINIMUM TEMPERATURES FROM 1883 TO 1916 INCLUSIVE (*continued*).
(Highest and Lowest Record for Each Month in Heavy Type.)

	May.				June.				July.				August.			
	MAX.		MIN.		MAX.		MIN.		MAX.		MIN.		MAX.		MIN.	
	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.
1883	11	87.	1 & 14	31.	7	86.5	2	42.	5	89.	1	46.	23	92.	15	46.
1884	24	88.	30	32.	25	90.	15	41.	2	87.5	15	50.	20	95.	25	44.
1885	18	81.7	3	27.5	14	86.5	23	41.5	18	90.5	12	46.5	1	89.	28	45.
1886	23	79.5	17&18	37.2	14	86.2	1	42.2	7	95.	1	45.2	30	91.5	6	47.7
1887	23	88.2	14	37.5	17	89.2	15	47.7	3	95.5	11	58.7	3	88.5	8	46.
1888	13	79.8	3	29.	23	94.1	4	40.	5	89.8	16	47.	9	92.6	23	48.3
1889	18	91.8	29	32.	22	85.	5	46.	11	90.7	6	50.5	31	86.7	16&17	50.3
1890	4	80.7	2	30.	30	85.6	8	44.8	9	94.5	24	46.5	4	96.2	24	46.0
1891	11	85.5	4	29.5	16	95.	6	40.	14	92.	31	46.	12	92.	29	46.5
1892	31	78.	9	34.2	14	92.	11	45.8	29	96.3	2	46.4	10	95.5	28	49.
1893	25	88.	9	35.	21	94.	1	44.	26	95.5	24	48.4	11	94.5	13	49.
1894	2	85.4	14	32.6	23	91.6	6	39.	21	97.	10	49.6	25	93.	27	45.3
1895*	31	92.	13&21	36.	3	96.	7	54.	8	94.	11	52.	11	88.	22	44.
1896	11	87.5	7 & 20	40.	21	89.	3	41.	3	94.	18	49.	6 & 7	96.	29	44.
1897	24	80.	8	32.5	24&25	87.5	2	42.	11	97.	15	57.	15	87.5	21	46.
1898	29	79.	6	34.	9	90.	16	40.	4	96.5	12	40.	24	90.5	28	47.
1899	2	87.5	15	32.5	6 & 24	93.	11	41.5	4	97.5	1	50.	20	97.5	15	44.5
1900	15&16	88.5	7	27.	25	93.	10	45.	17	96.	1	50.	11	97.	2	51.
1901	23	78.	16	36.	27, 28 & 29	95.5	2	42.	1	97.5	20	54.5	22	90.	5	52.
1902	22	90.	11	26.	3	85.	6	38.	14&27	90.	1	53.	31	90.	13	47.
1903	19	89.	2	24.	30	86.5	1	39.	9	94.	15	50.	18	85.5	8 & 14	45.
1904	25	88.	12	31.5	5–24 & 25	89.	12&17	45.	19	93.	3	49.	25	89.5	19	45.
1905	3	82.	2	29.5	19	90.	1	40.	18	92.	22	48.5	10	93.	27	41.
1906	24	88.5	11&21	30.	8	92.	12	37.	20–22 & 23	89.	25	50.	5	93.	16	47.
1907	14	85.	2–11 & 12	28.	18	94.	3	41.	16	90.	4	46.	12	96.5	19	41.5
1908	29	90.	1–4&5	31.	19	92.	12	43.	6–11 & 30	94.	9	52.	4	95.	25	46.
1909	31.	78.	2 & 3	33.	28	90.	8	43.	15	92.	4	42.	8	98.	31	42.
1910	20	79.	16	31.5	22	89.9	4	36.	9	96.5	5	50.	3 & 15	90.	27	44.
1911	22	97.	3	27.	11	90.5	17	46.	5	105.0	25–26 & 27	50.	8	94.5	30	47.
1912	24	88.	14	34.	1	89.	8	40.	8 & 10	95.	1	41.	14	92.	17	44.
1913	4	91.	11	30.	30	92.	9	37.	1 & 4	95.	12	50.	17	98.	25&26	44.
1914	26&27	90.	1	34.	24&25	90.	20	39.	11	93.	4	50.	9	94.	26	47.
1915	23	77.	3 & 4 10&27	34.	18&19	86.	4 & 9	41.	31	90.	22&23	49.	1	89.	27	43.
1916	24&28	82.	10&19	37.	27	82.	1	41.	30	96.	1	49.	22	101.	2&29	46.

* Data from record kept by Mr. Edgar Parker for the year 1895; Station record not available.

MONTHLY MAXIMUM AND MINIMUM TEMPERATURES FROM 1883 TO 1916, INCLUSIVE (*concluded*).

(Highest and Lowest Record for Each Month in Heavy Type.)

	SEPTEMBER.				OCTOBER.				NOVEMBER.				DECEMBER.			
	MAX.		MIN.		MAX.		MIN.		MAX.		MIN.		MAX.		MIN.	
	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.
1883	17	80.	11	37.	11	78.	17&18	25.	22	70.	17	13.	9 & 14	56.	23	—7.5
1884	5	94.	14	26.	5	84.2	27	23.	11	62.	25	15.	31	55.5	20	—15.5
1885	27	83.7	24	40.	1	79.	13	25.	8 & 13	68.	28	18.	24	53.	9	4.
1886	11	89.5	22	49.	10	76.7	17	27.5	3	68.2	28	17.	11&25	46.	6	—6.
1887	22	81.7	27	37.2	9	78.5	31	21.2	28	68.	30	15.	12	54.7	2	—3.
1888	1 & 10	83.	7	40.	6	62.7	22	29.	1 & 3	73.	23	8.	27	53.	22	4.
1889	4	84.	22 & 23&29	40.	2	68.7	24	21.2	4	61.7	17	17.8	25	60.5	4 & 5	8.
1890	8	83.6	25	35.5	5	69.8	31	32.	8	65.4	28	17.	1	46.2	20	3.
1891	26	92.8	30	43.	4	89.4	12&25	27.	1	68.	29	12.	5	57.7	18	7.
1892	26	88.	20	39.	1	82.	2	33.1	19	60.	24	18.	9	49.2	27	—3.7
1893	5	80.	26	37.4	13	76.	31	25.	3	62.	27	19.	26	62.	14	1.5
1894	4	90.	26	33.	1	76.5	15	33.	3	65.	29	12.	17	59.	29	—0.2
1895*	4	94.	15&30	42.	2	72.	30	28.	7	68.	21	19.	20&21	62.	13	—2.
1896	12	95.	23	36.	30	77.5	10&19	29.	19	70.	21	19.5	14	58.	28	2.
1897	11	98.	21	37.5	16	88.	10&18	30.	6	65.	24	16.5	12	61.5	24	2.
1898	4	94.	21	40.5	1	85.5	28	31.	5	63.	28	16.	31	54.	14	3.
1899	4	92.	15&30	30.	15	86.	3	26.	19	60.	14	25.	12	60.	31	—1.
1900	12	95.	19	37.	6 & 7	89.	20	28.	22	70.	17	19.	4	55.	10&14	4.
1901	6	89.	26	36.	10&11	74.	28	28.	1	65.	27	13.	14	62.	18	—1.
1902	1	90.	15	38.	19	74.	10 & 22&30	29.	14	73.	29	22.	2	52.	9	—5.
1903	14	90.	29	35.	1	73.	25&27	28.	4	70.	26&27	12.	3	46.	19	—4.
1904	3	88.	23	33.	10	81.	31	22.	3	65.	29	9.	23	53.	16	—2.
1905	30	88.5	26	36.	1	85.	26	20.5	12	61.	14	11.	29	52.5	15	1.
1906	18	91.5	25	38.	5	79.5	13&31	30.	19	62.	30	16.	6	52.	8	—1.
1907	20	90.	27	39.	†3	80.	31	24.	1	59.	12&16	22.	30	57.	22	13.5
1908	10	92.	30	37.	18	83.	21	27.	26	68.	5	18.	1	64.	23	3.
1909	14	93.	2 & 6	35.	9	82.5	29&30	27.	11	75.	24	21.	6	45.	30	1.
1910	6	87.	15&23	40.	6	81.	30	26.	1	59.	23	21.	29	41.	31	—2.5
1911	2	87.	14	35.	4	78.	3	33.	11	68.	13	18.	9	67.9	4 & 30	13.
1912	6 & 10	95.	30	34.	6	83.	16	31.	6 & 7	69.	28	20.	6	65.	9 & 12	12.
1913	3	95.	15	28.	6	81.	31	29.	22	73.	27	22.	7	56.	28	6.
1914	22	92.	29	38.	10	84.	27	26.	1	69.	24	16.	2	64.	26&27	—6.
1915	14	93.	28	35.	13	75.	25	29.	1	68.	18	21.	25	45.	31	4.
1916	7	93.	30	39.	8	87.	27	29.	8	74.	25	16.	5	62.	30	4.

* Data from record kept by Mr. Edgar Parker for the year 1895; Station record not available.
† Thermometer broken on the 27th, 28th, and 29th of October.

YEARLY MAXIMUM AND MINIMUM TEMPERATURES FROM 1883 TO 1916 INCLUSIVE.

(Highest and Lowest Record for THE TIME in Heavy Type.)

	Maximum for Each Year.		Minimum for Each Year	
	Date.	Temp.	Date.	Temp.
1883	Aug. 23	92.	Jan. 11	— 9.
1884	Aug. 20	95.	Dec. 20	—15.5
1885	July 18	90.5	Feb. 11	—11.5
1886	July 7	95.	Jan. 13	—18.7
1887	July 3	95.5	Jan. 19	— 8.
1888	June 23	94.1	Feb. 10	— 7.
1889	May 18	91.8	Feb. 4 and 24	— 7.
1890	Aug. 4	96.2	Mar. 8	2.
1891	June 16	95.	Feb. 15	2.5
1892	July 29	96.3	Jan. 10	— 5.
1893	July 26	95.5	Jan. 11	— 6.
1894	July 21	97.	Feb. 27	— 8.5
1895*	June 3	96.	Feb. 8	—14.
1896	Aug. 6 and 7	96.	Feb. 17	**—21.**
1897	Sept. 11	98.	Jan. 20	— 3.5
1898	July 4	96.5	Jan. 30 and 31	— 4.
1899	July 4 and Aug. 20	97.5	Feb. 11	— 8.
1900	Aug. 1	97.	Feb. 27	0.
1901	July 1	97.5	Feb. 24	2.5
1902	May 24, July 14 and 27, August 31 and Sept. 1	90.	Dec. 9	— 5.
1903	July 9	94.	Feb. 18 and Dec. 19	— 4.
1904	July 19	93.	Feb. 16	—18.
1905	Aug. 10	93.	Feb. 5 and 14	— 6.
1906	Aug. 5	93.	Feb. 6 and 7	— 7.
1907	Aug. 12	96.5	Jan. 24	—18.
1908	Aug. 4	95.	Jan. 2 and 5	—14.
1909	Aug. 8	98.	Jan. 19	— 7.
1910	July 9	96.5	Jan. 5	— 8.
1911	July 5	**105.**	Jan. 5	— 1.
1912	Sept. 6	95.	Jan. 14	—12.
1913	Aug. 17	98.	Feb. 10	—10.
1914	Aug. 9	94.	Feb. 13 and 24	—14.
1915	Sept. 14	93.	Jan. 30	— 3.
1916	Aug. 22	101.	Feb. 15	— 8.

* Data from record kept by Mr. Edgar Parker; Station record not available.

MONTHLY AND YEARLY MEANS OF TEMPERATURES SINCE 1882.

YEAR.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Yearly averages.
1883	17.4	22.3	23.6	43.3	52.0	66.6	67.4	65.6	56.3	46.6	39.1	27.5	44.0
1884	17.6	28.3	29.5	40.7	54.3	67.1	66.5	69.9	65.2	50.5	36.5	27.2	46.1
1885	20.6	11.4	18.8	41.2	54.3	63.6	69.7	65.0	58.3	49.2	39.3	27.8	43.3
1886	19.6	22.9	30.2	48.1	55.7	64.0	68.0	67.5	61.8	49.6	36.8	22.2	45.5
1887	20.2	23.2	26.3	41.1	62.5	65.7	75.6	66.5	57.7	47.0	37.6	27.6	45.9
1888	16.4	22.8	24.6	40.8	54.3	66.5	66.8	68.0	62.2	43.9	39.4	29.3	44.6
1889	29.1	18.1	33.9	45.1	58.4	65.3	70.2	66.0	60.5	44.0	40.3	35.2	47.2
1890	31.2	30.9	28.8	44.2	52.3	67.1	69.5	67.7	60.1	49.3	37.6	21.4	46.7
1891	25.9	28.3	30.8	45.3	52.0	66.4	66.4	68.5	66.2	48.3	38.4	35.5	47.7
1892	21.4	25.9	26.5	43.5	52.8	68.6	70.2	69.4	61.2	50.0	35.9	25.2	45.9
1893	15.5	20.6	29.5	41.1	54.1	68.2	69.8	68.8	58.0	52.0	38.2	27.5	45.3
1894	29.7	20.6	38.9	44.1	55.5	67.8	74.2	66.8	64.9	52.7	36.0	31.5	48.6
1895	21.8	16.9	26.9	44.4	59.0	......	......	71.2	61.7	45.4	39.6	31.4	....
1896	22.4	24.1	24.4	49.3	62.0	65.9	71.4	70.0	60.2	56.5	42.9	27.1	48.0
1897	23.2	26.1	33.8	45.0	55.4	62.3	73.6	67.6	62.3	52.6	39.7	29.2	47.6
1898	26.2	26.8	......	43.2	57.0	67.7	74.2	71.0	65.9	52.1	37.9	27.9	....
1899	22.1	20.4	30.4	46.6	57.6	69.5	71.2	71.6	60.6	53.5	38.9	30.0	47.7
1900	26.0	22.6	23.6	43.5	56.7	68.4	72.6	74.1	66.1	57.9	41.1	28.7	48.4
1901	26.1	18.5	32.2	46.5	56.9	68.9	76.6	71.0	64.0	51.4	34.3	27.7	47.9
1902	23.2	22.2	39.5	46.6	56.1	63.2	71.2	67.6	53.6	43.1	46.3	25.7	47.4
1903	25.7	28.1	42.2	45.9	60.4	63.2	70.8	65.5	64.4	52.5	36.2	23.3	48.2
1904	18.9	23.1	30.9	41.4	60.3	67.8	70.0	68.2	61.9	48.4	36.9	22.5	45.9
1905	19.8	18.9	33.1	44.8	57.5	66.4	71.8	68.7	63.7	52.4	37.6	32.0	47.2
1906	32.5	26.1	27.6	46.4	57.5	68.2	71.4	72.8	67.3	51.2	37.9	26.1	48.8
1907	24.9	19.5	38.1	40.2	51.3	64.0	71.2	68.4	64.4	47.9	38.7	31.8	46.7
1908	25.9	21.3	34.6	44.8	59.2	68.8	73.4	68.8	67.0	52.9	40.0	29.2	48.8
1909	27.7	28.6	31.0	44.3	57.9	67.2	69.6	70.0	63.5	47.7	44.5	25.7	48.1
1910	25.1	22.1	42.1	50.1	54.9	65.2	73.1	69.0	63.2	53.1	35.7	21.5	47.9
1911	24.9	26.6	30.9	44.8	64.9	67.5	74.4	70.9	62.8	50.7	36.6	35.1	49.4
1912	15.9	21.6	28.2	45.1	58.9	64.3	73.2	68.6	68.4	53.5	42.5	33.9	47.8
1913	32.7	18.8	36.9	48.3	56.9	66.8	72.1	70.0	61.3	54.0	44.5	33.6	49.7
1914	25.4	17.7	31.7	43.4	60.2	67.3	59.9	70.5	61.4	55.4	39.2	26.0	46.5
1915	26.5	29.6	31.0	52.3	52.6	64.6	69.6	67.8	65.6	52.6	41.1	28.5	48.5
1916	29.0	19.5	27.5	49.5	59.5	61.5	72.5	73.5	66.0	58.0	45.0	33.0	49.5
Monthly averages	23.9	22.8	30.9	44.8	56.8	66.2	70.9	69.0	62.6	50.7	39.1	28.5	47.2

PRECIPITATION BY RAINFALL ONLY BY MONTHS SINCE 1882.

YEAR.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Total.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
1882	......	......	......	......	......	3.69	2.42	2.37	1.25	0.62	1.22	0.55	......
1883	0.48	1.44	0.88	1.58	4.45	4.12	2.98	3.47	2.12	2.10	1.54	0.73	25.89
1884	1.83	2.01	2.54	0.83	2.49	2.01	2.83	1.44	3.17	1.67	1.01	0.97	22.30
1885	1.07	0.61	0.12	1.26	1.58	2.49	4.64	5.02	2.11	2.88	1.36	0.76	23.90
1886	1.13	0.95	1.18	4.13	1.92	2.92	4.41	2.86	2.31	1.79	3.48	1.24	27.87
1887	0.18	2.97	0.48	1.37	0.46	2.01	6.37	3.03	0.75	1.74	1.58	1.35	22.29
1888	0.78	1.04	1.43	3.09	2.79	2.88	0.99+	4.02	2.73	3.47	2.02	1.24	20.48
1889	2.99+	0.25	0.66+	3.28	1.21	7.47	4.57	1.98	2.50	3.32	3.44	1.62	32.28
1890	2.16	1.45	2.16	2.20	5.49	4.26	1.07	4.34	5.81	4.54	2.40	......	36.88
1891	1.44	1.57	3.25	1.63	0.49	4.31	3.52	3.16	0.47	2.65	0.74	3.29	27.52
1892	0.57	0.88	0.55	0.67	4.04	3.95	1.89	4.77	1.12	1.34	1.67	0.72	23.17
1893	1.62	3.71	1.94	2.59	4.92	3.08	2.68	5.38	2.68	1.59	1.09	1.56	33.84
1894	2.21	2.71	1.36	2.43	7.03	1.77	1.50	1.22	4.64	3.59	0.48	0.47	29.36
1895	0.96	......	0.29	1.36	2.88	......	......	2.66	0.94	0.72	2.31	2.49	......
1896	1.19	2.28	0.84	0.41	2.31	3.71	4.12	3.33	4.27	2.26	2.18	0.71	27.61
1897	0.64	0.21	2.12	1.90	2.19	3.16	5.28	1.27	2.36	0.73	2.53	1.39	23.78
1898	1.74	0.33	1.54	2.03	1.90	2.37	1.82	3.60	1.86	3.83	2.03	0.33	22.90
1899	0.37	0.30	1.22	1.12	1.69	1.71	4.15	1.05	2.23	2.69	1.36	1.46	19.35
1900	1.43	2.42	0.02	0.95	1.71	1.45	6.53	1.75	0.91	3.65	6.13	0.78	27.73
1901	0.72	......	2.19	4.43	3.80	2.07	3.97	5.52	2.46	1.35	2.09	3.37	31.97
1902	0.86	0.66	1.94	1.92	2.84	4.33	5.29	2.41	2.88	2.32	0.74	0.74	26.89
1903	1.81	1.11	5.62	2.60	0.23	7.77	4.86	7.21	1.30	4.19	1.63	0.38	38.69
1904	0.80	1.03	2.41	1.67	4.04	3.37	5.73	2.56	3.26	2.06	0.26	1.42	28.61
1905	0.40	0.27	1.09	2.05	2.01	8.78	3.59	5.44	1.90	3.69	1.32	1.84	32.38
1906	1.46	0.53	1.60	2.08	4.24	5.31	2.37	3.68	2.16	3.56	1.40	1.54	29.93
1907	1.89	0.08	1.14	2.42	1.82	2.34	2.86	1.35	2.73	2.48	2.78	1.89	24.73
1908	0.68	1.12	1.24	3.28	3.57	1.96	4.72	1.79	1.66	2.73	0.88	0.43	24.06
1909	0.94	1.68	1.35	3.20	2.83	2.17	2.04	2.21	2.22	1.18	0.56	0.49	20.87
1910	0.87	0.53	0.28	4.56	3.45	1.55	2.39	5.47	3.29	1.73	0.62	0.38	25.12
1911	0.91	0.24	1.07	3.24	1.36	2.51	4.49	3.36	3.21	2.37	1.41	2.08	26.25
1912	0.20	0.95	1.92	3.41	7.27	2.09	4.85	2.21	5.89	1.42	1.48	1.13	32.82
1913	3.88	0.11	4.64	3.40	2.68	3.24	2.08	1.65	2.64	4.03	2.41	0.77	31.48
1914	0.98	0.15	1.28	3.10	4.00	2.69	2.18	6.05	1.62	1.55	1.08	1.13	25.81
1915	2.34	1.77	0.30	0.64	2.41	2.57	2.44	5.90	1.78	4.44	1.93	1.23	27.75
1916	2.69	1.05	0.50	3.40	5.69	5.83	1.78	3.47	2.15	1.41	1.83	1.49	31.29
Averages	1.30	1.14	1.50	2.30	3.00	3.41	3.42	3.34	2.44	2.45	1.73	1.24	27.44

TOTAL PRECIPITATION: RAINFALL AND SNOW REDUCED TO EQUIVALENT RAINFALL, 1915-16.

YEAR.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Total.
1915	3.82	2.67	0.65	0.64	2.41	2.57	2.44	5.90	1.78	4.44	2.03	4.06	33.41
1916	3.44	4.97	5.02	3.40	5.69	5.83	1.78	3.47	2.15	1.41	2.53	3.22	42.95
Averages	3.63	3.82	2.83	2.02	4.05	4.20	2.11	4.68	1.96	2.92	2.28	3.64	38.18

INDEX.

A. Page.

Acidity of milk and milk serum 253
Actinomycetes in soil, function of 73
Agar *vs.* gelatin plates for counting bacteria 91
Agrilus sinuatus (See Sinuate borer).
Agronomy, Division of, summary of work 17
Aleochara bilineata and *A. bipustulata*, parasites of cabbage maggot 389
Alfalfa seed, results of inspection 529
Alsike clover seed, results of inspection 531
Anametis granulata (See Peach leaf weevil).
Anderson, R. J., bulletins by 257, 271
Animals, utilization of inosite by 257
Anthomyidae, habits and character of 343
Anthony, R. D., bulletin by 481
Aphides (See Plant lice).
Aphidicide, use of lime as 324
Aphis avenæ, *A. pomi* and *A. sorbi* (See Plant lice).
 rosy apple, oat and green apple (See Plant lice).
Apple aphides and their control 759
 cork, drouth spot and related diseases of 156
 orchards, control of plant lice in 297
 Perfect, description of 497
 transpiration of young fruits and leaves 195
 trees, effect of spraying with insecticides on 312, 316
  young, control of green apple aphis on 322
Apples, effect of insecticides on plant lice on 315
 influence of aphides on growth of 303
 Rome, lime-sulphur and nicotine on 310
 varieties affected by drouth spot and similar diseases 158
Archips argyrospila and *A. rosaceana* (See Leaf roller).
Aromatic constituents of urine 271
Aspidiotus perniciosus (See San Jose scale).

B.

Backus, F. L., spraying experiments in orchard of 327
Bacteria, agar *vs.* gelatin for plate method of counting 91
 counting through microscope 37
 counts, standardization of microscope for making 59
 in milk, microscopical method of counting 43
 microscopical method of counting, history of 38
 of soil, notes on studies 20
 satisfactory number of colonies on agar plates 82
 spore forming, significance in soil 66

Page.

Bacterial analysis of milk, accuracy of methods 19
Bacteriological department, report of 35
quality of milk, effect of barn factors on 19
Bacteriology, summary of work in 18
Bacterium cereum, *B. megatherium* and *B. mycoides* in soil 67
Baer, Wm. W., appointment as Assistant Chemist 8
Baker, John C., appointment as Associate Chemist 7
Bark, rough and smooth, of raspberries, inheritance 489
Barn factors, effect on bacteriological quality of milk 19
Beckwith, John, spraying experiments in orchard of 333
Bibliography of cork and drouth spot of apple 203
plant-disease transmission by insects 153
Black leg of cabbage 522
rot of cabbage 522
Blister-mite on pear 469
Blue grass seed, results of inspection 533
Board of Control, members of v
Bordeaux mixture *vs.* lime-sulphur for potatoes 22, 206
Borers attacking pear 455
Bosworth, A. W., bulletin by 247
Botany, Department of, report 95
summary of work in 22
Breed, Robert S., bulletin by 37, 82
Breeding raspberries, notes on 31, 481, 766
Brew, James D., bulletin by 37
Buchholz, A. B., supervision of plant-lice experiments 335
Bud moth on pear 464
Building needs of Station 12
new, appropriation for 12
Bulletins reprinted, No. 414, 495; No. 415, 297; No. 416, 527; No. 417, 481; No. 418, 510; No. 419, 340; No. 420, 607; No. 421, 206; No. 422, 97; No. 423, 424; No. 424, 215; No. 425, 547; No. 426, 156; No. 427, 503; No. 428, 7.
Bulletins reprinted, Popular No. 415, 759; Popular No. 418, 769; Popular No. 419, 772; Popular No. 422, 778; Popular No. 423, 782.
Bulletins reprinted, Technical No. 48, 247; Technical No. 49, 37; Technical No. 50, 136; Technical No. 51, 66; Technical No. 52, 73; Technical No. 53, 82, 91; Technical No. 54, 257; Technical No. 55, 271; Technical No. 56, 402.
Bulletins issued during 1916 33
Burrows, Lynn, spraying experiment in orchard of 336

C.

Cabbage, culture of 520
diseases 521
early, protection against maggots 397
tar pads for protecting 399

Page.

Cabbage, harvesting . . . 523
insects . . . 522
looper . . . 523
maggot adults and fruit blossoming . . . 362
capturing with sticky fly-paper . . . 395
descriptions of . . . 352, 353
destruction by poisoned bait . . . 393
dispersion of . . . 359
habits of . . . 360
and its work . . . 522, 772
biology and control . . . 26, 340, 351
conditions for normal development . . . 383
distribution of . . . 349
duration of egg stage . . . 374
duration of larval period . . . 353
duration of puparium stage . . . 356, 377
economic importance of . . . 345
effect of moisture and temperature on incubation period . . . 374, 375
effect of moisture on pupal development . . . 378
temperature on pupal development . . . 381
egg, description of . . . 351
emergence of spring brood adults . . . 357
thru different soil depths . . . 358
experiments of control of . . . 393
farm practices to prevent injuries from . . . 401
hibernation of . . . 371
host plants of . . . 349
larva, description of . . . 351
length of pupal stage . . . 386
life history and habits of . . . 353
stages of . . . 351
natural enemies . . . 388
number of broods . . . 365
origin of . . . 350
oviposition habits . . . 364
predaceous enemies of . . . 393
protection of early cabbage from . . . 397
pupae, loss of moisture from . . . 385
screening for control of . . . 396
puparium, description of . . . 352
seasonal activity of . . . 355
selection of host plants . . . 354
summarized methods of control . . . 398
synonymy of . . . 344

Page.
Cabbage maggot, time between emergence and egg laying................ 363
uneven development of pupae 384
roots, injuries by maggots.................................. 356
seasonal susceptibility to maggot injury........................ 355
seed-beds, screening against maggots........................... 396
production 524
storage... 523
varieties of.. 524
worm, imported.. 523
Cankers, formation by use of tree-cricket excrement........................ 147
tree cricket, description of................................ 140
Carbolic acid emulsion, formula for use against plant lice 338
Carman No. 2 potato, degeneration in................................ 121
Carpocapsa pomonella (See Codling moth).
Chemical changes in souring milk..................................23, 247
Chemistry, department of, report.. 214
summary of work 23
Cherry leaf beetle, discussion of.. 471
distribution 471
feeding habits 471
life history 471
outbreak of.. 28
remedial measures.. 472
Reine Hortense, description of.. 500
Chicory and endive culture.. 511
for winter salads 513
varieties of 511
Witloof (See Witloof chicory).
Chionaspis furfura (See Scurfy scale).
Chrysobothris femorata (See Borers on pear).
Cicada, periodical (See Periodical cicada).
Circulars reprinted, No. 47, 239; No. 48, 520; No. 49, 471; No. 50, 474; No. 51, 453.
issued during 1916.. 34
Clover seed, alsike, results of inspection 531
results of inspection.. 534
Club-root of cabbage.. 521
Codling moth on pear 458
Color correlation in leaf and fruit of raspberries........................ 492
of raspberry fruit, inheritance.. 488
Commissioner of Agriculture, letter of transmittal........................ iii
Conn, H. Joel, bulletins by..66, 73, 91
Conotrachelus nenuphar (See Plum curculio).
Contarinia pyrivora (See Pear midge).
Cork and drouth spot of apple, control.................................. 201
orchard observations 172

Page.
Cork drouth spot and related diseases of the apple 156
of apples, difference from fruit pit, bitter pit or stippen 162
economic importance 161
history and distribution 159
pathological histology 168
seasonal history 171
symptoms 162
Cow, non-phenolic volatile oils of urine of 272
Crops, plant food for, for 1916 239

D.

Dairy division, summary of work in 18
Degeneration of potatoes 23, 778
observations 97
Department of Bacteriology, report 35
Botany, report 95
Chemistry, report 214
Entomology, report 295
Horticulture, report 479
Die-back and rosette of apples, orchard observations 186
of apples, pathological histology 170
symptoms of 166
Diospilus polydrusi, description of 422
parasite of leaf weevil 420
Director's report 7
Diseases of cabbage 521
Dodder found in seed samples 546
Dog, effect of inosite upon respiratory exchange 258
Dotterrer, W. D., bulletin by 82, 91
Drouth spot and cork of apple, cause 190
cork and die-back of apples, connection 189
experimental production of 197
of apple, pathological histology 168
removal of foliage to prevent 199
seasonal history 170
symptoms of 164
Dwarf types of raspberries 491

E.

Endive, culture of 511
varieties of 513
Entomological Division, summary of work 25
Entomology, Department of, report 295
Erannis tiliaria (See Lime-tree winter-moth).
Eriocampoides limacina (See Pear slug).
Eriophyes pyri (See Blister-mite).

Page.
Ermine moths, apple and cherry, discussion of........................ 425
larval activities........................ 429
occurrence in New York........................ 425
susceptibility to arsenicals........................ 431

F.

False tarnished plant bug on pear........................ 459
Feeding-stuffs inspection, analyses in........................ 25
report of inspection........................ 607
Fertilizers, analyses in inspection work........................ 25
analyses of........................ 548
for cabbage........................ 520
inspection, results of........................ 547
Fertility and composition of soils........................ 221
soil, measurements of........................ 215
Fish-oil soap, formula for use against plant lice........................ 337
Flea beetles on cabbage........................ 522
Fly-paper, sticky, for capturing cabbage-maggot adults........................ 395
Freeman, H. H., spraying experiments in orchard of........................ 329
Fruit of raspberries, inheritance of color........................ 488
pests, new or rare........................ 782
plants, species of, grown at Station........................497, 505
Fruits, new or noteworthy........................30, 31, 495, 503
number of varieties grown at Station........................497, 505
Fulton, B. B., article by........................ 449
bulletin by........................ 136
Fungi, passage through digestive tract of tree crickets........................ 142
tree crickets as carriers of........................22, 136

G.

Gahan, A. B., description of *Diospilus polydrusi*........................ 422
Galerucella cavicollis (See Cherry leaf beetle).
Gelatin *vs.* agar plates for counting bacteria........................ 91
Gibson, H. B., spraying experiments in orchard of........................ 334
Gifford, E. S., spraying experiments in orchard of........................ 329
Glasgow, H., bulletin by........................ 402
Glaucousness of raspberry canes, inheritance........................ 489
Gloyer, W. O., bulletin by........................ 136
Goat, non-phenolic volatile oils of urine of........................ 283
Gooseberry fruit worm, appearance of injury........................ 446
control measures........................ 449
description of stages........................ 448
distribution........................ 447
food plants........................ 447
habits........................ 447
life history........................ 447

Page.
Gooseberry fruit worm, literature of. 445
on currants. 445
outbreak of. 28
Grape, Empire State, description of. 500
Graphiphora alia (See Green fruit worm).
Grass seed, blue, results of inspection. 533
orchard, results of inspection. 539
red top, results of inspection. 539
Green apple aphis, seasonal behavior of. 302
fruit worm, description of stages. 450
destructive to young apples. 28
on apple, discussion. 449
pear. 465
Mountain Jr. potatoes, degenerate strains in. 99, 101
potato, degeneration in. 126

H.

Hall, F. H., popular bulletins by. 759, 766, 778, 782
Hartzell, F. Z., bulletin by. 471
Harwood, B. S., spraying experiments in orchard of. 326
Hedrick, U. P., bulletins by. 403, 495
Hodgkiss, H. E., bulletins by. 297, 424
circular by. 474
Horse, non-phenolic volatile oils in urine of. 288
Horticulture, Department of, report. 479
summary of work. 30

I.

Inosite, effect upon metabolism of man. 264
effect upon respiratory exchange in dog. 258
utilization in animal organism. 24, 257
Insecticides, effect on plant lice on apples. 315
Insects affecting cabbage. 522
attacking pear. 453
injurious, miscellaneous notes. 27, 424
literature of transmission of plant diseases by. 137
Inspection of feeding stuffs, report of. 607
work, chemical analyses in. 25
quantity of. 17
report on. 525
Ionia potato, degeneration in. 123

J.

Jordan, W. H., bulletin by. 215

K. Page.

Kerosene emulsion, formula for use against plant lice 337
Knoxal potato, degeneration in 122

L.

Lactic acid, formation in souring of milk 252
Land, acquirement of desirable 13
Larwood, John, spraying experiments in orchard of.. 331
Lathrop, F. H., bulletin by 297
Leafbeetle, cherry (See Cherry leaf beetle).
roll in potatoes, hereditary character of 124
rollers on pear 465
weevil, adult, description of 411
classification of 403
description of life stages 408
discovery in New York 406
discussion of 28, 402
distribution 407
in native habitat 406
economic importance of 405, 418
egg, description of 408
food plants of 412
host plants of 405, 417
introduction of 403
larvae, descriptions of 409
larval activities 416
length of incubation period 414
life history and habits 415
methods of control 421
method of importation 407
native status 403
natural enemies 420
on peach trees 28
willow, poplar and birch 28
oviposition habits 413
peach (See Peach leaf weevil).
pupa, description of 410
relationship 403
Lepidosaphes ulmi (See Oyster-shell scale).
Leptosphaeria coniothyrium, tree crickets as carriers of 136
Lesser peach borer, adult 440
cocoon 439
description of injury 437
life stages 438
discussion of 436
distribution of 438
economic importance 438

Page.
Lesser peach borer, egg 439
habits 438
larva 439
life history 438
outbreak of 28
pupa 440
treatment 440
Lewis, Edward J., appointment and resignation as Assistant Chemist 7
Lice, plant (See Plant lice).
Lime as an aphidicide 324
sulphur and nicotine for plant lice on apples 310
vs. bordeaux mixture for potatoes 22, 206
tree winter-moth, biology of 442
description of life stages 443
discussion of 441
literature of 441
occurrence of 441
treatment 444
Linden canker worm, outbreak of 28
Long Island Wonder potato, degeneration in 121
Lygus invitus (See False tarnished plant bug).

M.

Maggot, cabbage (See Cabbage maggot).
Maintenance funds, appropriation and distribution of 9
Man, effect of inosite upon metabolism of 264
non-phenolic volatile oils in urine of 288
Metabolism of man, effect of inosite on 264
Meteorological records for 1916 795
Microscope, counting bacteria thru 37
standardization for making bacterial counts 59
Microscopical count of bacteria, difficulties in 60
possible inaccuracy of 62
method of counting bacteria in milk 43
grading 63
applications of 64
chances for error 44
history of 38
technique 43
Milk, accuracy of methods of bacterial analysis 19
and milk serum, acidity of 253
barn factors in bacteriological quality 19
chemical changes in souring 247
grading by means of microscopical bacteria counts 63
market, controlling sanitary quality of 18
microscopical method of counting bacteria in 43

Page.
Milk, souring, chemical changes in 23
Mix, A. J., bulletin by.......... 156
Munn, M. T., bulletins by..........206, 527

N.

New or noteworthy fruits..........30, 31
Newspapers received by Station.......... 787
Niagara County, control of plant lice in.......... 325
Nicotine and lime-sulphur for plant lice on apples.......... 310
solution, formula for use against plant lice 337

O.

Oat aphis, seasonal behavior of 301
Oils, volatile, of urine..........24, 271
Orchard grass seed, results of inspection.......... 539
Orchards, apple, control of plant lice in.......... 297
plant lice injurious in.......... 25
Orleans County, control of plant lice in.......... 329
Oyster-shell scale on pear 456

P.

Parrott, P. J., bulletins by 297, 402, 424, 471
circulars by..........453, 474
Peach borer, lesser (See Lesser peach borer).
J. H. Hale, description of 505
leaf weevil, discussion of..........28, 431
distribution of.......... 433
habits of.......... 434
methods of control.......... 435
Pearson, description of.......... 506
Rochester, description of.......... 498
" Peaches of New York," publication of 14
Pear, insects attacking 453
control of.......... 29
midge.......... 459
psylla.......... 467
slug.......... 469
thrips.......... 461
Periodical cicada, appearance in 1916.......... 29
distribution in New York 474
in 1916 474
injuries by 475
life history of.......... 474
methods of control.......... 476
Periodicals received by Station 787
Phoma oleracea on cabbage 522
wilt of cabbage.......... 522

Page.
Phorbia brassicae (See Cabbage maggot).
Pipettes, sterile, clean and dirty, effect on bacterial counts 48
used in microscopical method of counting bacteria 46
Plant diseases, literature of transmission by insects 137
food for crops for 1916 239
lice, combination sprays for 338
control in Orleans County 329
directions for spraying 338
effect of insecticide sprays on 312, 317, 323
experiments for control of, in Niagara County 325
green apple, control on young apple trees 322
in apple orchards 25, 759
influence on growth of apple 303
injurious, control in apple orchards 297
to apple orchards 25
lime as an insecticide for 324
method of treatment 337
newly hatched, control of 297
on cabbage 522
Rome apples, lime-sulphur and nicotine for 310
seasonal behavior in apple orchards 299
time of spraying for 339
Plasmodiophora brassicae on cabbage 521
Plates, agar, for counting bacteria, number of colonies allowable 82
Plum curculio on pear 462
Drap d'Or, description of 507
Plums, Mirabelle, description of 507
Poison bait, destruction of cabbage maggots by 393
Popular bulletins, reprints of 759
Potatoes, degeneration and seed selection 134
degeneration of 23
inheritance of forms of degeneration 131
lime-sulphur *vs.* bordeaux mixture for 22, 206
nature of forms of degeneration 133
net necrosis 130
observations on degenerate strains 97
recommendations for spraying 211
running out of 778
stem end browning 130
Polydrusus impressifrons (See Leaf weevil).
Precipitation record 806
Pride of Vermont potato, degeneration in 125
Pseudomonas campestris on cabbage 522
Pseudoeucoila gilletei, parasite of cabbage maggot 391
Psylla pyricola (See Pear psylla).

Page.
Publications, edition of 14
issued during 1916, list of 33

R.

Rainfall record, monthly, for 34 years 806
Rape seed, results of inspection 539
Raspberries, abnormal development of flower clusters 490
breeding 31, 481, 766
correlation of leaf and fruit color 492
dwarf types of 491
hybrid between species 493
inheritance of color of fruit 488
purple, origin of 484
Raspberry breeding at Station, history 483
cane characters, inheritance 489
Cumberland, transmission of characters 487
Empire, description of 508
Herbert, description of 501
transmission of characters 487
Marlboro, transmission of characters 486
Smith No. 1, transmission of characters 487
Red top grass seed, results of inspection 539
Report of Director 7
Treasurer 1
Rosette of apples, symptoms of 166
Rosy apple aphis, seasonal behavior of 300
Rubus odoratus hybrid with common raspberry 493
" Running out " of potatoes 23
Rural New Yorker No. 2 potato, degeneration in 122

S.

Salads, winter, from chicory 513
Sanitary quality of market milk, control 18
San Jose scale on pear 456
Saperda candida (See Borers attacking pear).
Schoene, W. J., articles by 436, 441
bulletin by 340
Scurfy scale on pear 457
Seed examination, voluntary 545
inspection, comments on 543
law 528
samples, dodder found in 546
tests at Station 1915 527
Seeds, results of inspection of 529
Sinuate borer on pear 453

Page.
Snyder, G. E., spraying experiments in orchard of.......... 334
Soil composition, determination by use of hydrochloric acid.......... 222
fertility, measurements of.......... 215
flora studies, notes on.......... 20
for cabbage.......... 520
function of Actinomycetes in.......... 73
materials freed by shaking with solvents:
In water.......... 236
In hydrochloric acid.......... 237
materials made soluble by percolation:
With water.......... 224
With dilute hydrochloric acid.......... 229
With stronger hydrochloric acid.......... 233
significance of spore-forming bacteria in.......... 66
Soils, composition and fertility.......... 221
Species of fruit plants, number grown at Station..........497, 505
Spindling sprout of potatoes not correlated with mosaic, leaf roll and curly dwarf.......... 129
Spines of raspberries, inheritance.......... 489
Spraying for plant lice, directions.......... 338
materials, combinations for use against plant lice.......... 338
mixtures for plant lice.......... 337
potatoes, recommendations.......... 211
Staff, changes in.......... 7
restrictions by State Fiscal Policy.......... 8
State Fiscal Policy, effect on Station Staff.......... 8
of Maine potato, degeneration in.......... 120
Station activities, discussion of policy.......... 15
work in 1916, summary of.......... 17
Stewart, F. C., bulletin by.......... 97
Stone, Wm. C., appointment as Assistant Horticulturist.......... 8
Strawberry, Good Luck, description of.......... 509
Strickland, L. F., supervision of plant-lice experiments.......... 335
Synanthedon pictipes (see Lesser peach borer).

T.

Tabor, C. D., spraying experiments in orchard of.......... 326
Taeniothrips pyri (See Pear thrips).
Tar pads for protecting early cabbage.......... 399
paper pads, tool for cutting.......... 400
Temperatures, air, for 1916..........796, 797, 798, 799, 800
maximum and minimum, 1916..........798, 799, 800
monthly maximum and minimum for 34 years..........801, 802, 803
monthly mean for 34 years.......... 805
yearly maximum and minimum for 34 years.......... 804

Page.
Thermometer readings, 1916 .... 796, 797, 798, 799, 800
Time of spraying for plant lice 339
Timothy seed, results of inspection 540
Tmetocera ocellana (See Bud moth).
Transpiration of fruits and leaves of apple 195
Treasurer's report 1
Tree cricket canker, description of 140
excrement, cankers formed by use of 147
Tree crickets as carriers of fungi 22, 136
control measures 151
passage of fungi thru digestive tract 142
Trombidium sericeum, parasite of cabbage maggot 392
Tubergen, Chas. B., resignation as Assistant Horticulturist 7

U.

Urine, aromatic constituents of 271
volatile oils in 24

V.

Van Slyke, L. L., bulletin by 247
circular by 239
Vetch seed, results of inspection 543
Victor potato, degeneration in 122
Volatile oils of urine 271

W.

Wellington, J. W., bulletin by 510, 520
Wilson, Charles S., letter of transmittal iii
Witloof chicory, bulletin on 32, 769
culture and forcing of 510
culture at Station 515
foreign methods of culture 513
notes on 32

X.

Xylina spp. (See Green fruit worm).

Y.

Yponomeuta malinellus and *Y. padellus* (See Ermine moths).

Z.

Zophodia grossularia (See Gooseberry fruit-worm).

INDEX TO ASSEMBLY DOCUMENTS 1917

A

	Doc. No.
Agriculture, State Department, annual report	11
Albion, Western House of Refuge for Women, annual report	22
American Scenic and Historic Preservation Society, annual report	51
American Society for Prevention of Cruelty to Animals, annual report	43
Antietam battlefield, report of New York Monuments Commission	23
Assembly, bills, supplemental index	62
committees, list	3
members	1

B

Batavia, New York State School for the Blind, annual report	33
Bath, New York State Soldiers' and Sailors' Home, annual report	5
Bills, Assembly, supplemental index	62
Blind, New York Institute for the Education of, annual report	34
Blind, New York State Commission for, annual report	12
Blind, State School, for, annual report	33
Boards, commissions and departments, *see specific names of.*	
Bronx Parkway Commission, report	7
Buffalo, LeCouteulex St. Mary's Institution for Deaf Mutes, annual report	39

C

Canals, report of Comptroller relating to expenditures on	28
Central New York Institution for Deaf Mutes, Rome, annual report	40
Charitable institutions, annual report of Commission on sites, grounds and buildings	30
Charities, Fiscal Supervisor, annual report	49
State Board of, answer to report of Commissioner Strong	8
Chattanooga battlefield, report of New York Monuments Commission	23
Commissions and departments, *see specific names of.*	
Committees of the Assembly	3
Comptroller, State, annual report	20
report on expenditures	16
report on expenditures on the canals	28
special report on municipal accounts	61
Conrad Poppenhusen Association, annual report	32
Conservation Commission, annual report	59
Cornell University, State Veterinary College, annual report	56
Crime, statistics of, annual report of Secretary of State	17

D

Deaf mutes, institutions for the instruction of	40, 41, 42, 45
Departments, *see specific names of.*	

E

Education Department, annual report	50
Excise, Commissioner of, annual report	29

F

Fire Island State Park Commission, annual report	14
Fiscal Supervisor of State Charities, annual report	49
Foods and Markets, State Department of, annual report	55